The Four Horsemen of the Apocalypse

© February 2012

The Four Horsemen

1. Oil Supply
2. The Pakistani Nuclear Weapons Programme
3. MENA Population Growth
4. Climate – the 210 year cooling cycle

The First Horseman

I watched as the Lamb opened the first of the seven seals. Then I heard one of the four living creatures say in a voice like thunder, "Come and see!" I looked, and there before me was a white horse! Its rider held a bow, and he was given a crown, and he rode out as a conqueror bent on conquest.
Revelation 6:1-2

Conquest:
Oil Supply

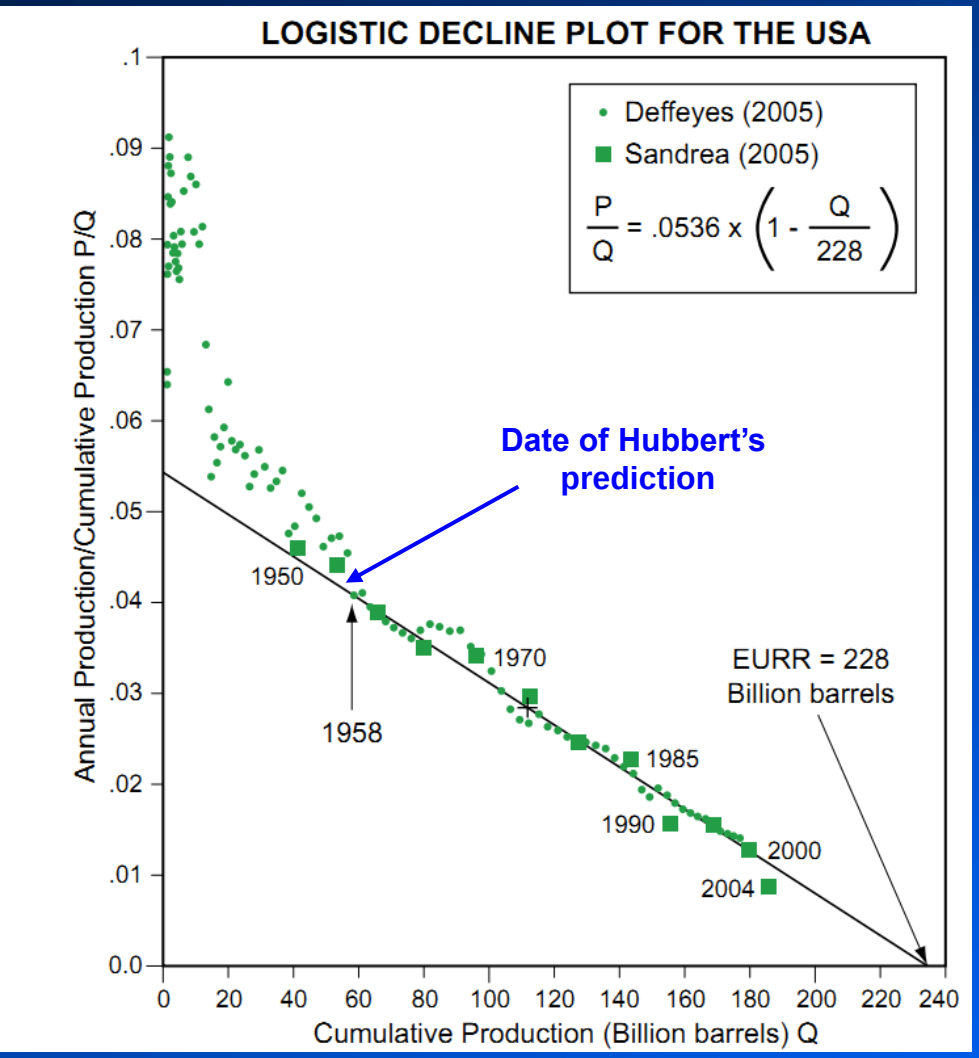
The Oil Price: What will drive everything.

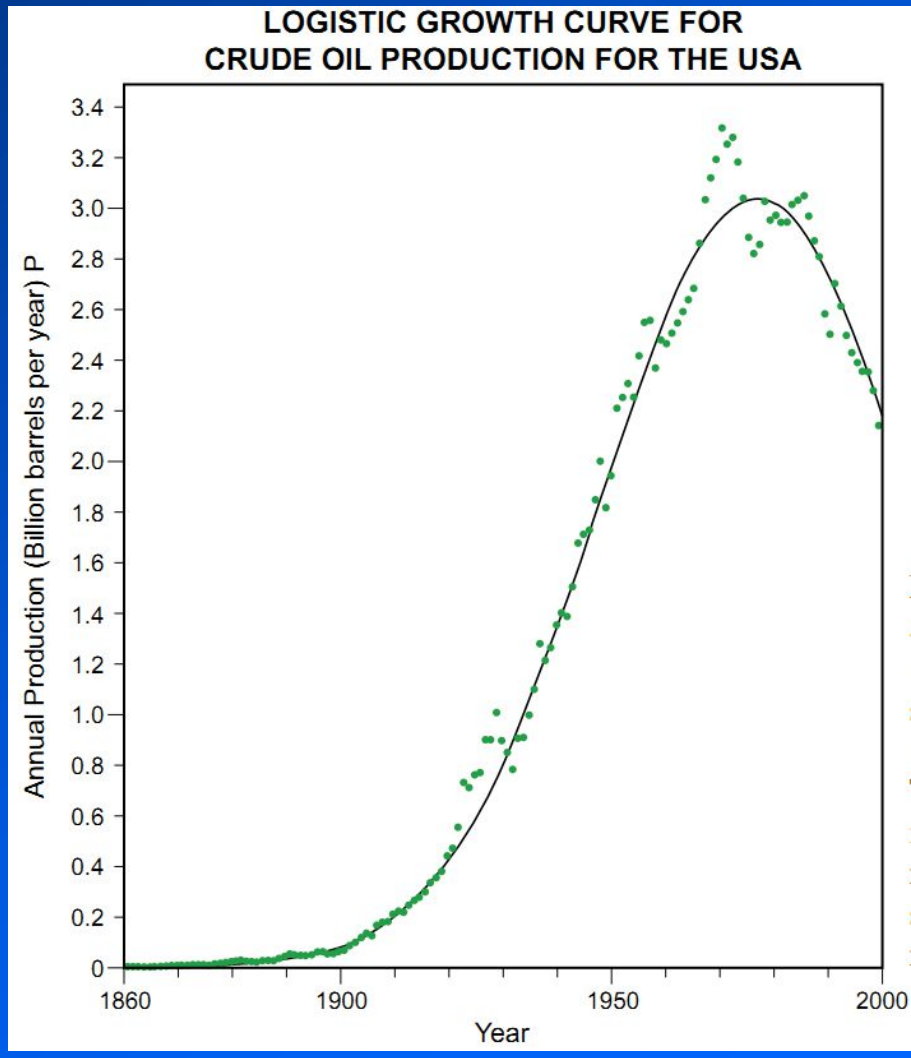
"One day we will run out of oil; it is not today or tomorrow, but one day we will run out of oil and we have to leave oil before oil leaves us, and we have to prepare ourselves for that day."

Fatih Birol, Chief Economist of the International Energy Agency

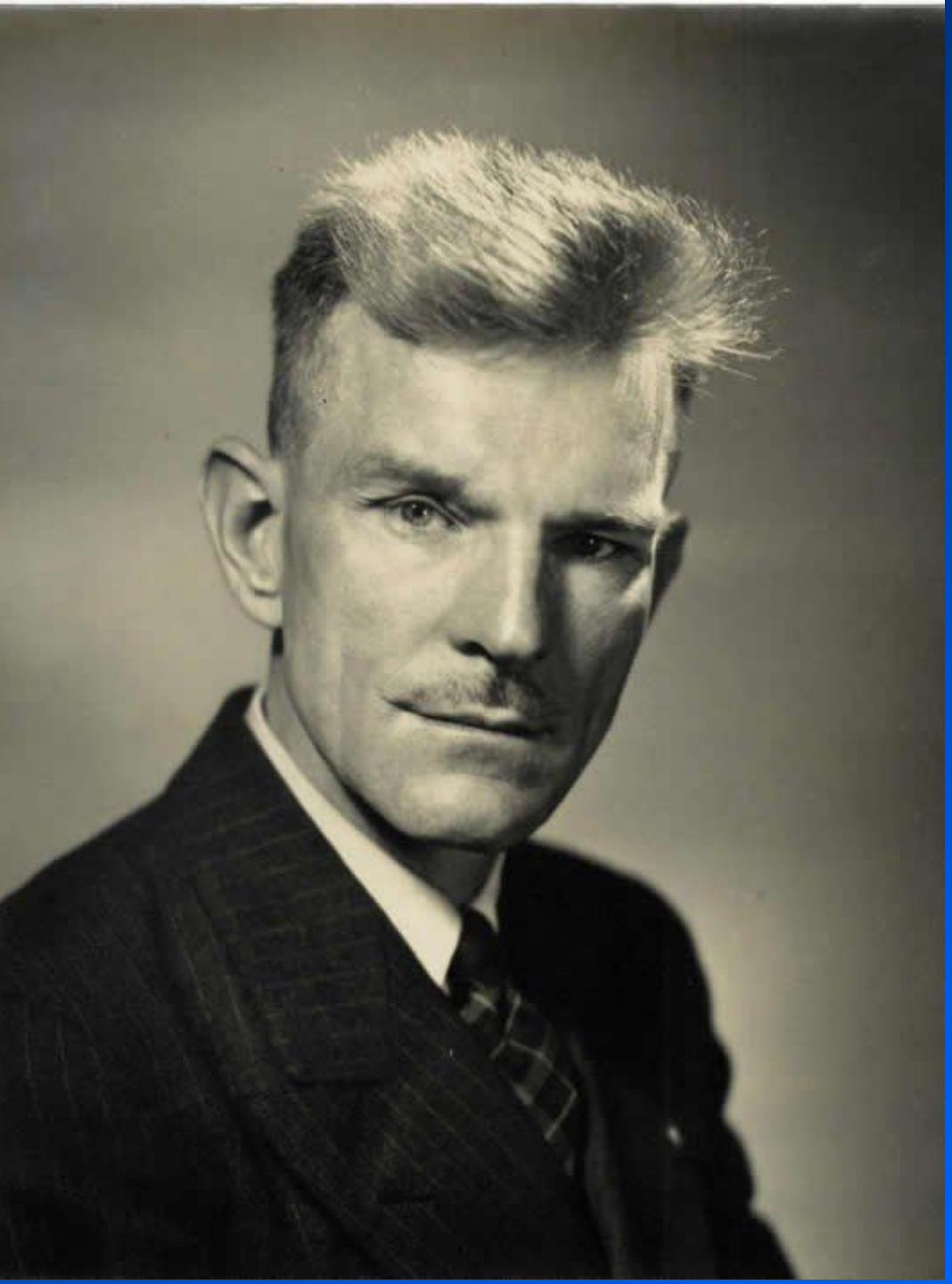
3rd August, 2009

The most successful economic prediction ever made





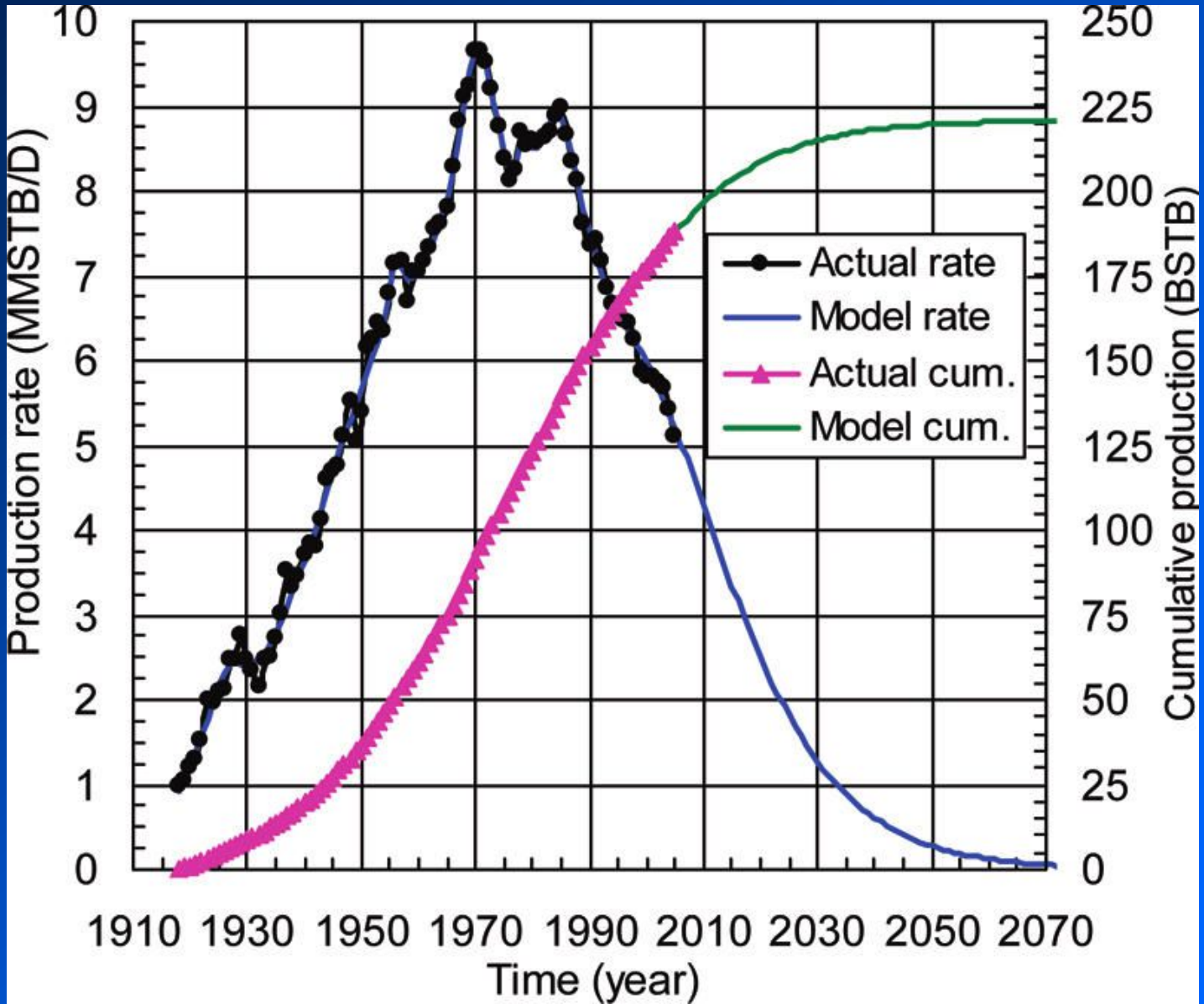
King Hubbert predicted in 1956 that US oil production would peak in 1970.

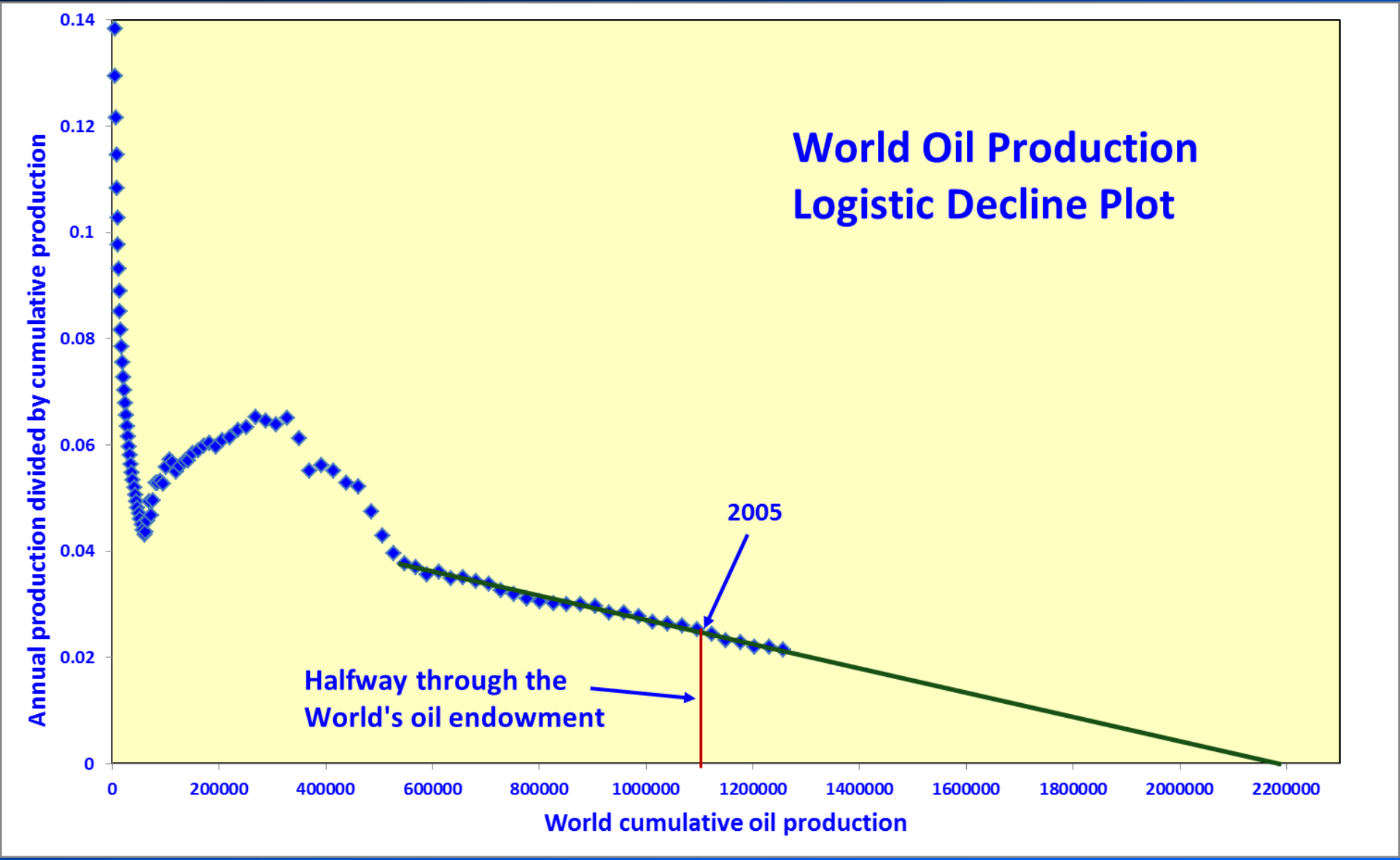


King Hubbert

at the peak of his predictive powers

US production decline has entered its fourth decade.





This is the cheap stuff - does not include shale oil, tar sands, natural gas liquids.

The decline will be 1.0 million barrels/day/year.

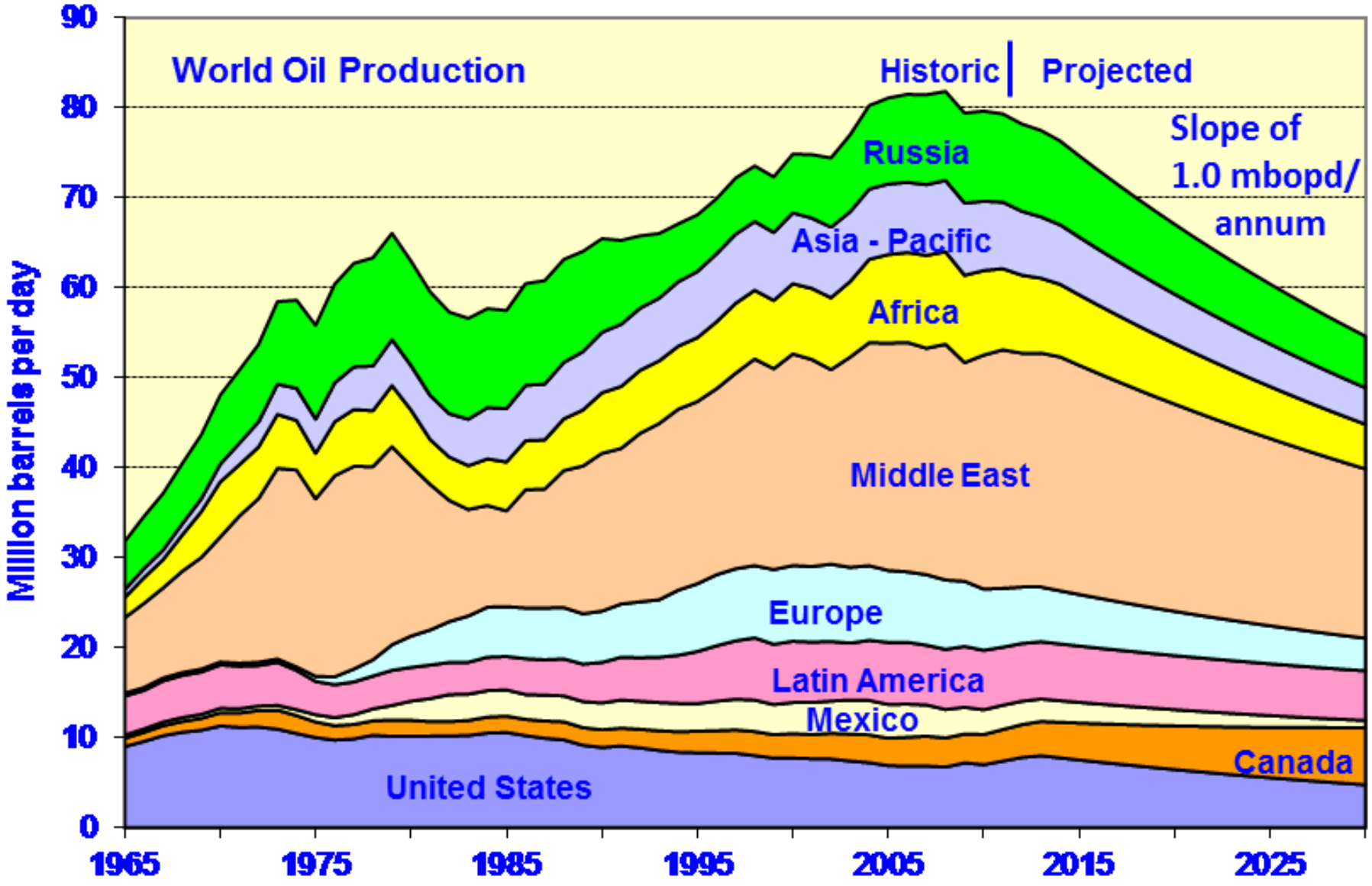
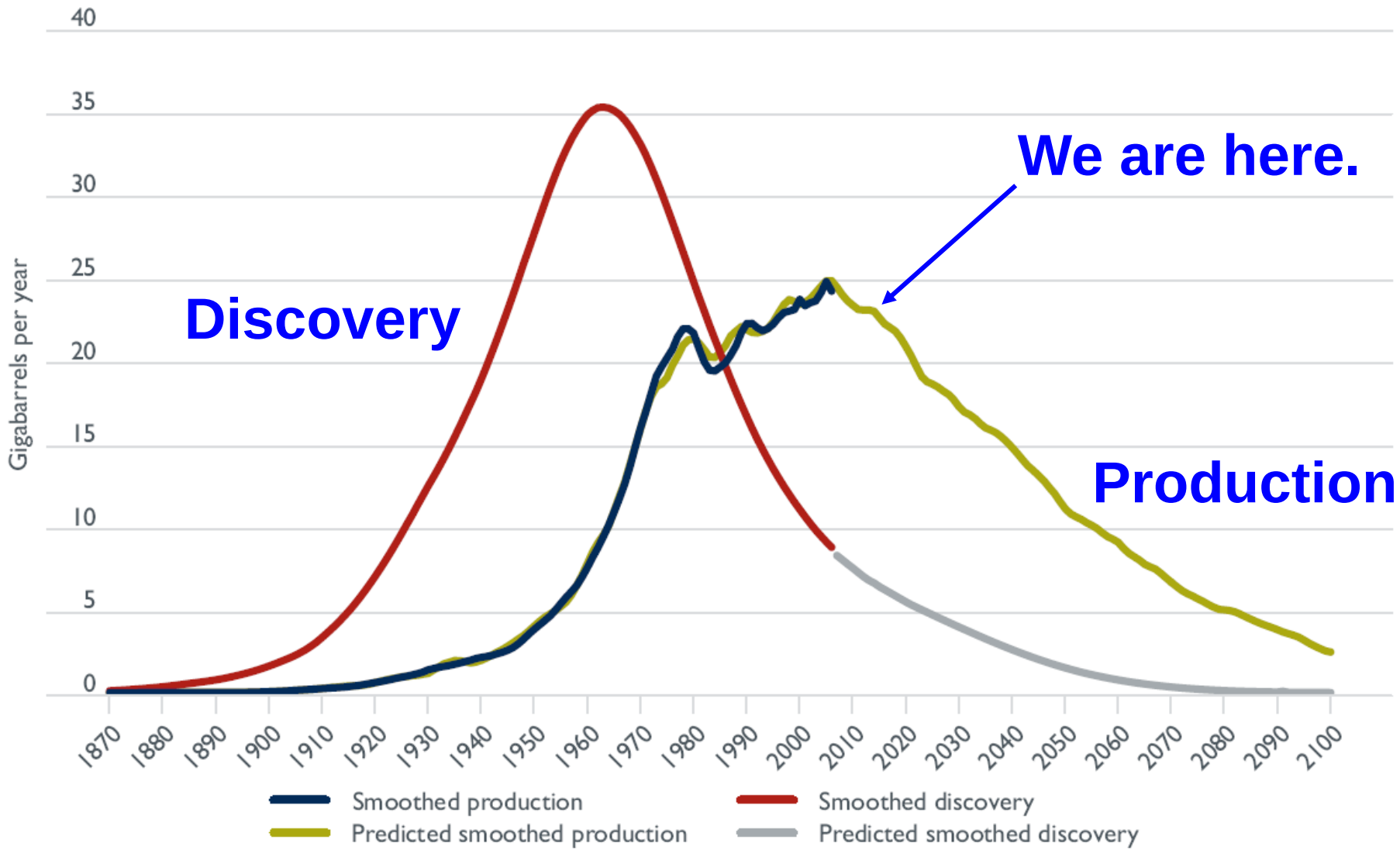
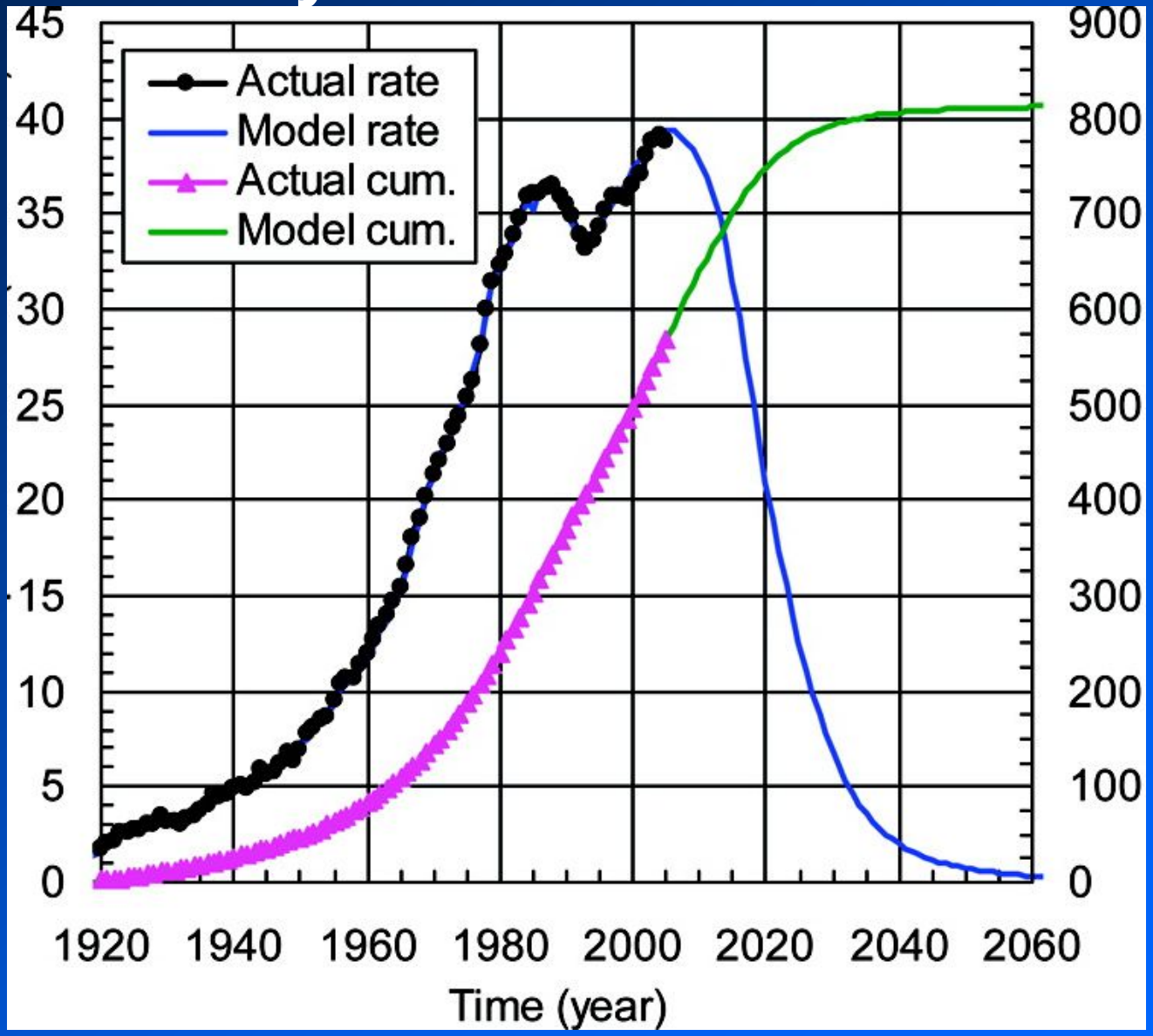


Figure 13.9 from Report 117
Report 117 was suppressed by the Australian Govt.



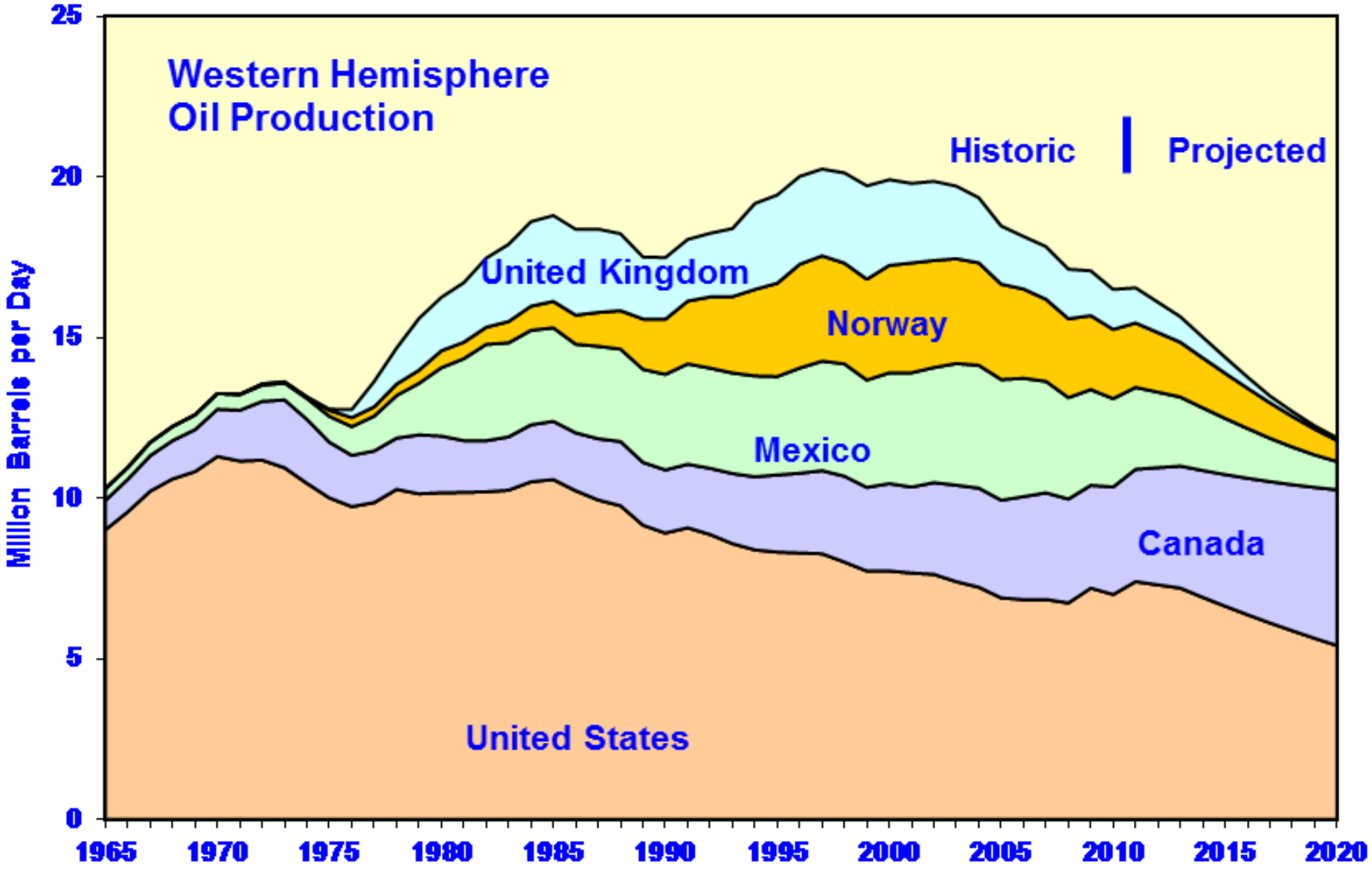
http://www.manicore.com/fichiers/Australian_Govt_Oil_supply_trends.pdf

Non-OPEC production will fall 20 million BOPD by the end of the decade.

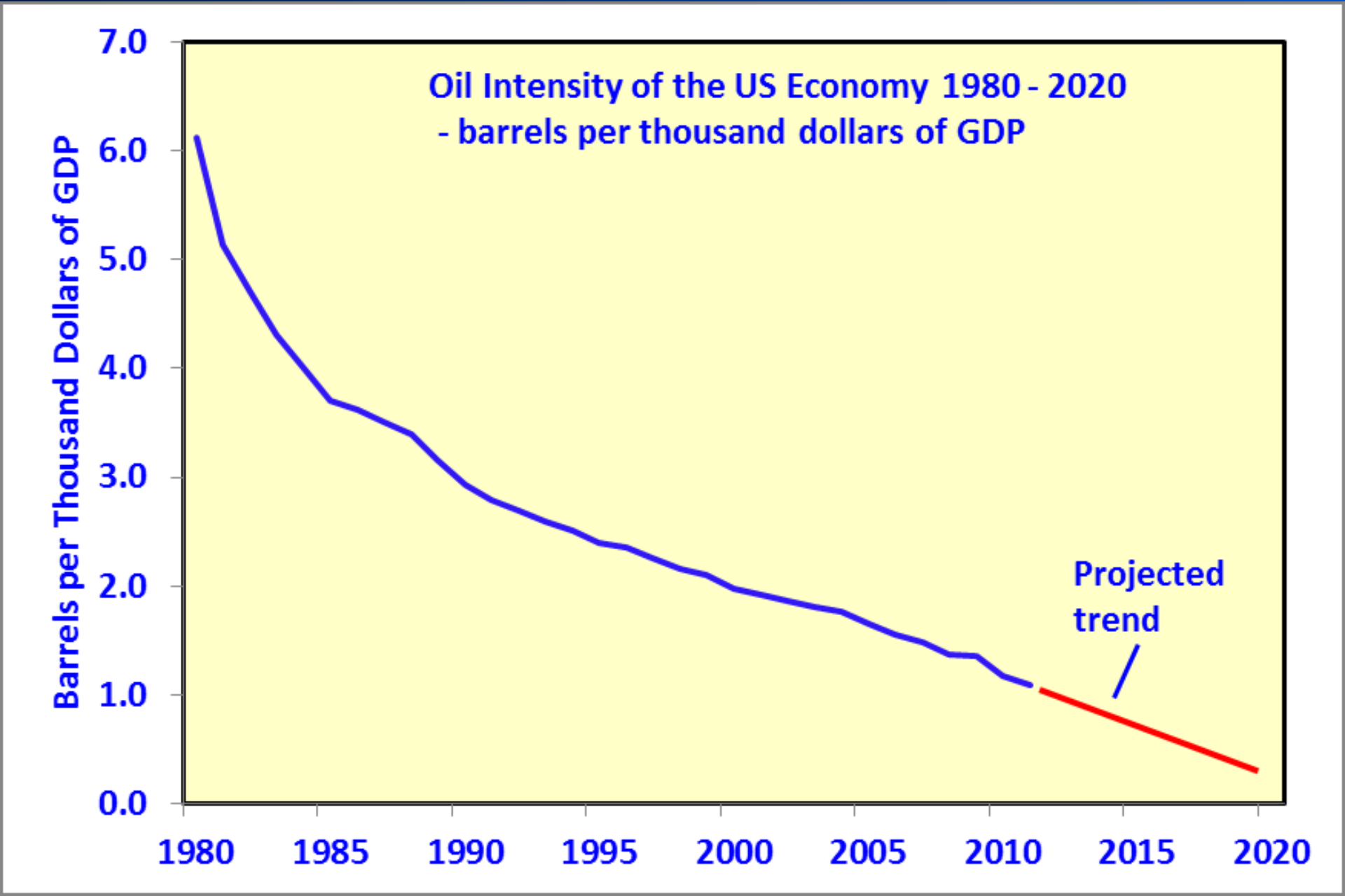


Source: http://pubs.acs.org/stoken/presspac/presspac/full/10.1021/ef901240p

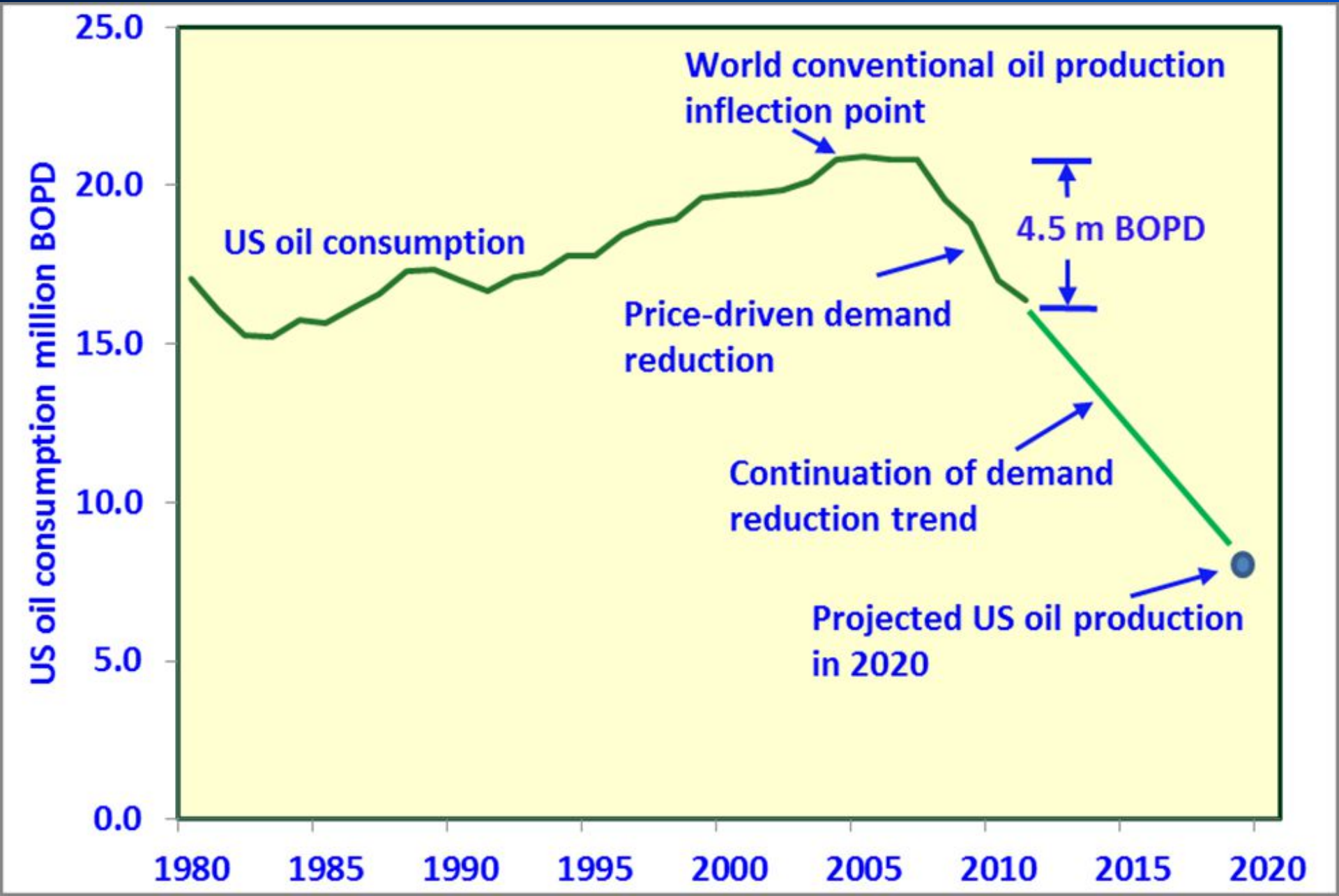
Western Hemisphere production contracts



Oil Intensity of the US Economy continues to drop.

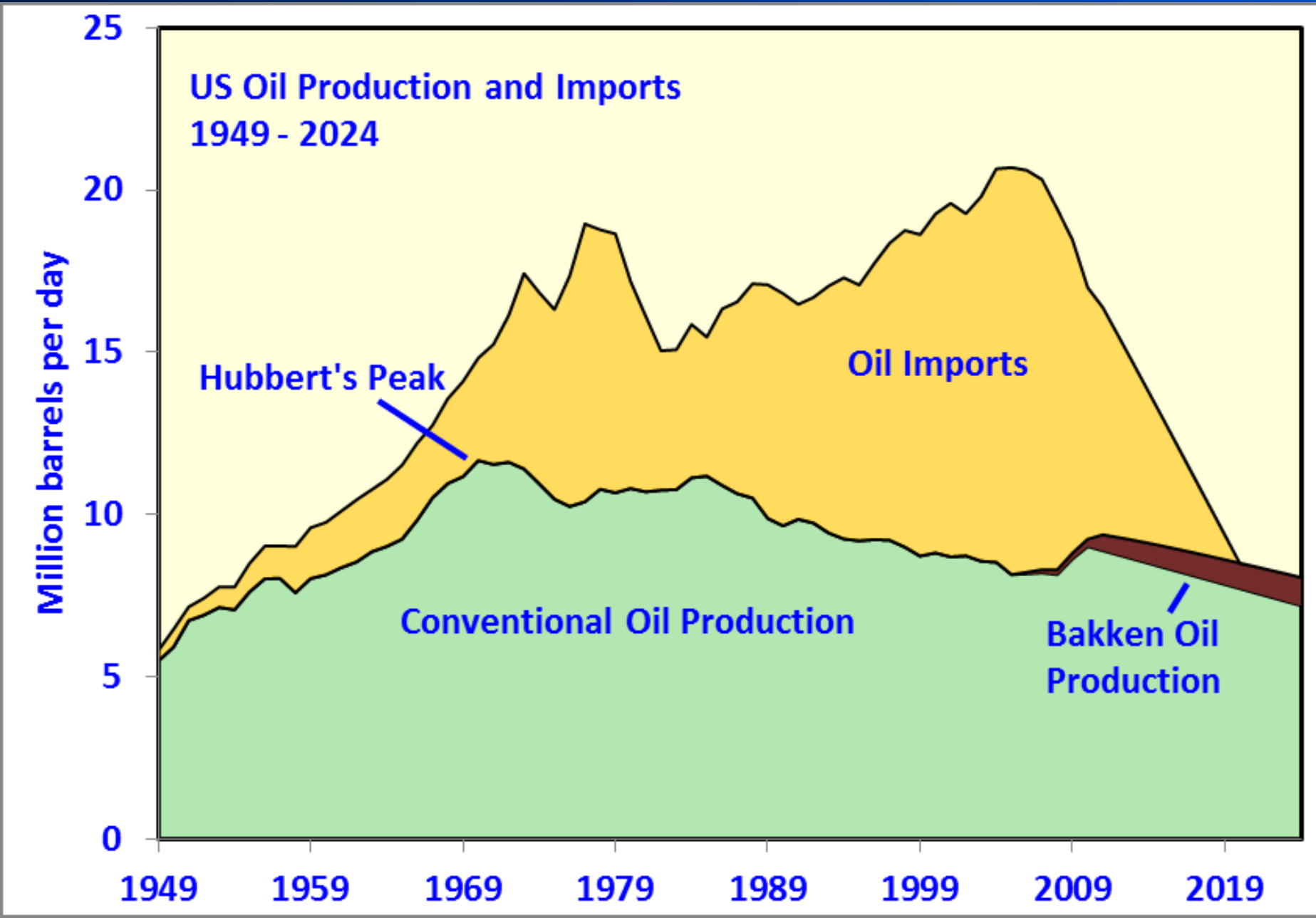


If the demand reduction trend continues

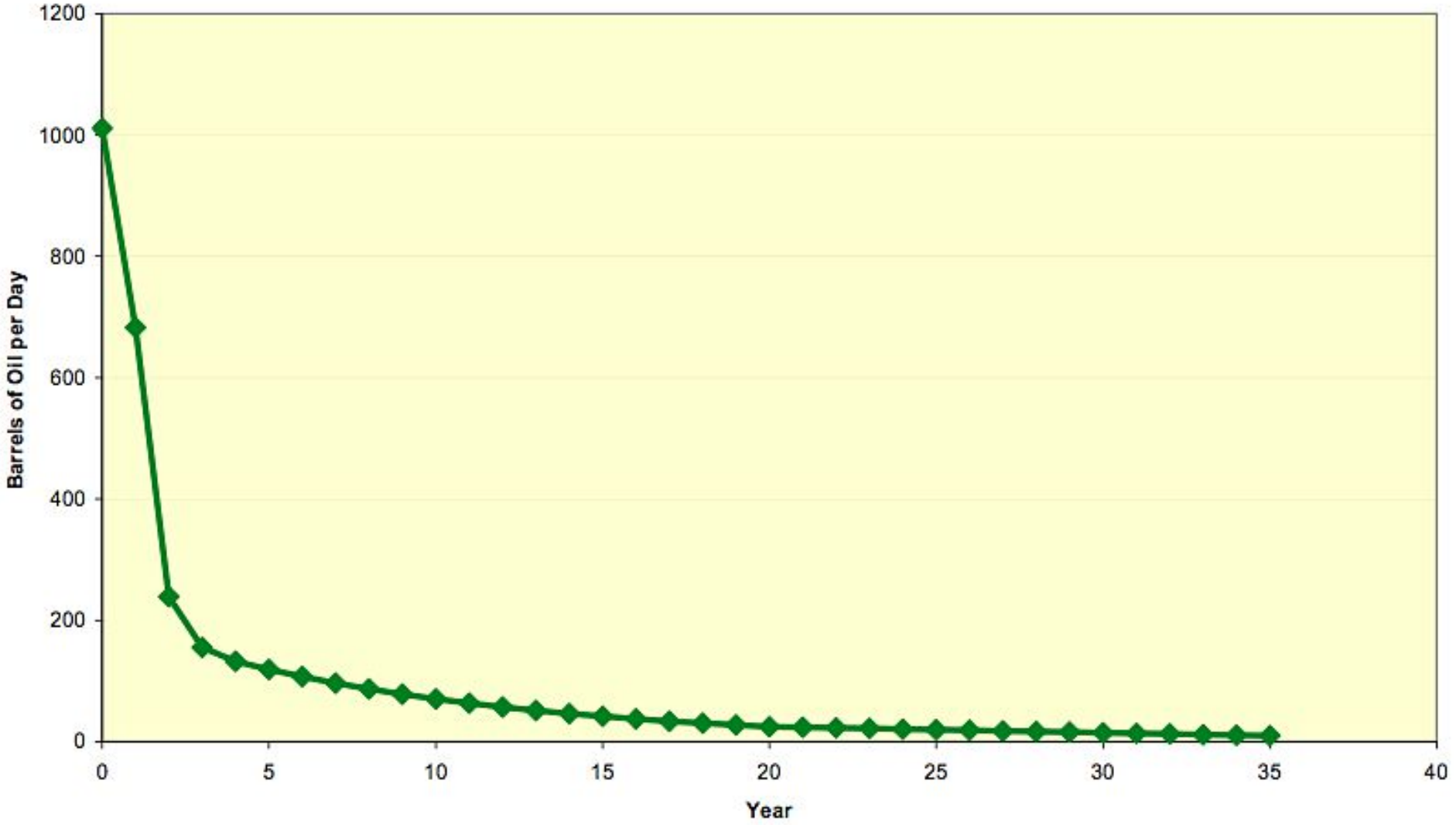


And it might get there much faster than that.

Price-Driven US Energy Independence

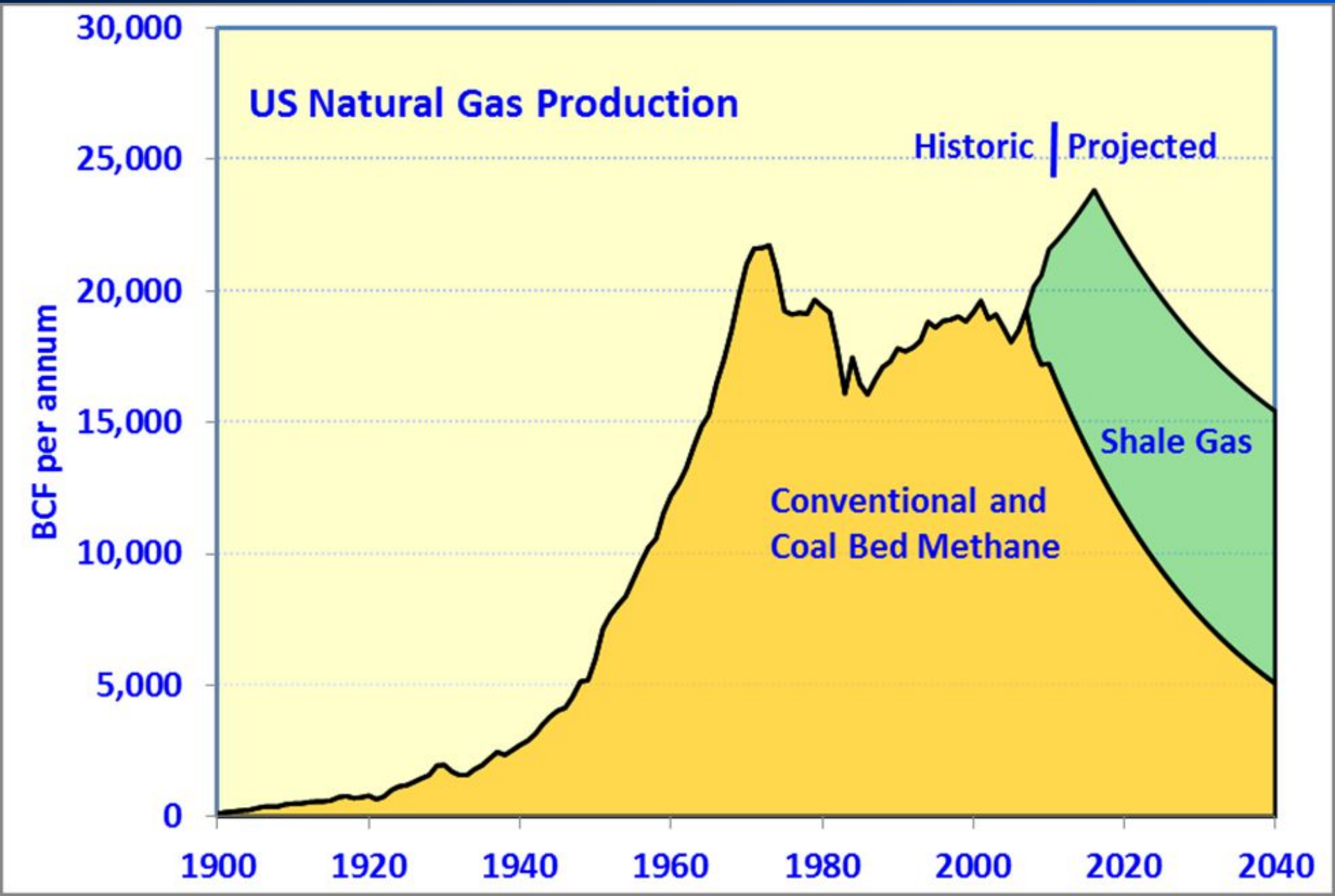


Typical Bakken shale oil production decline

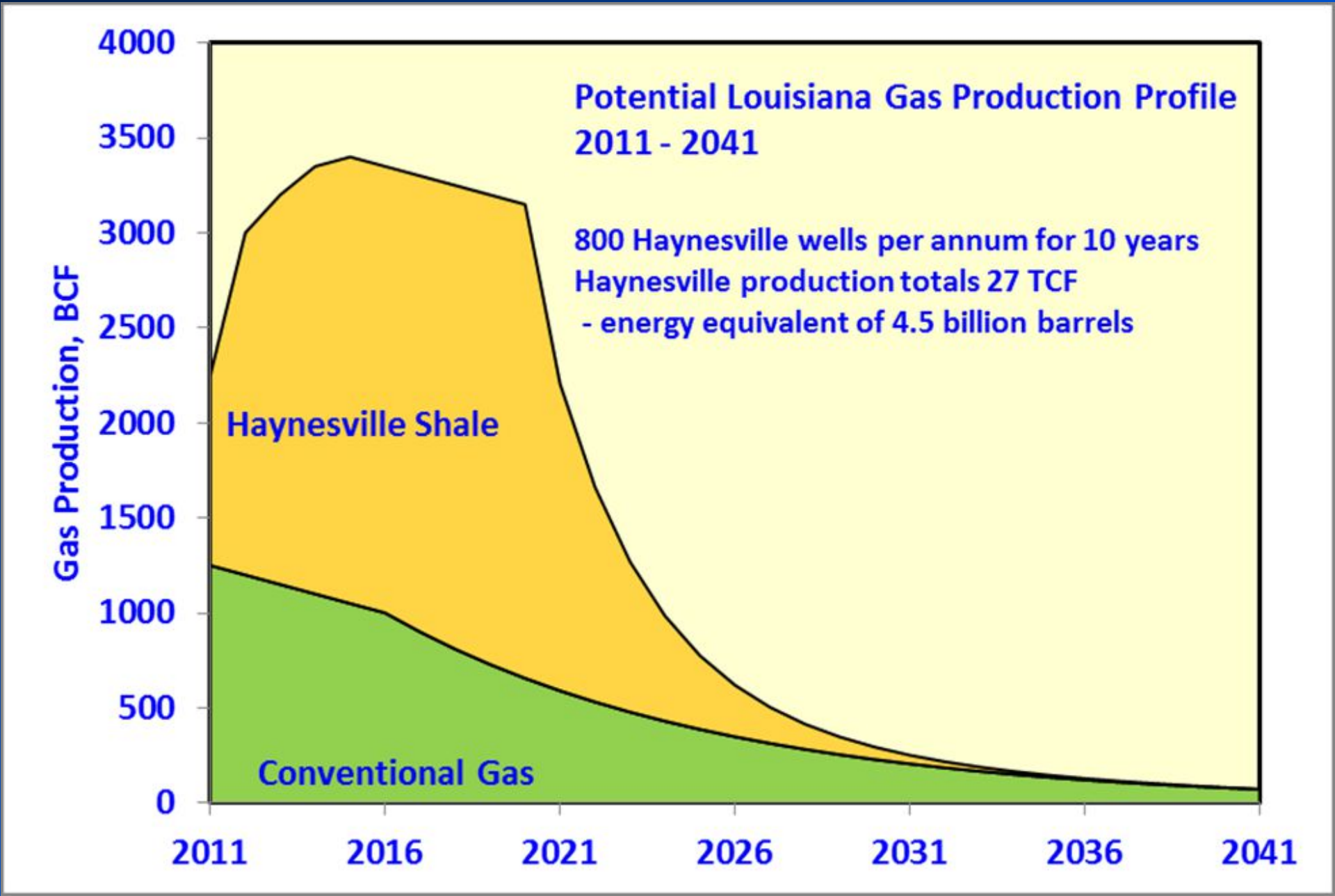


Down to 15% by year three

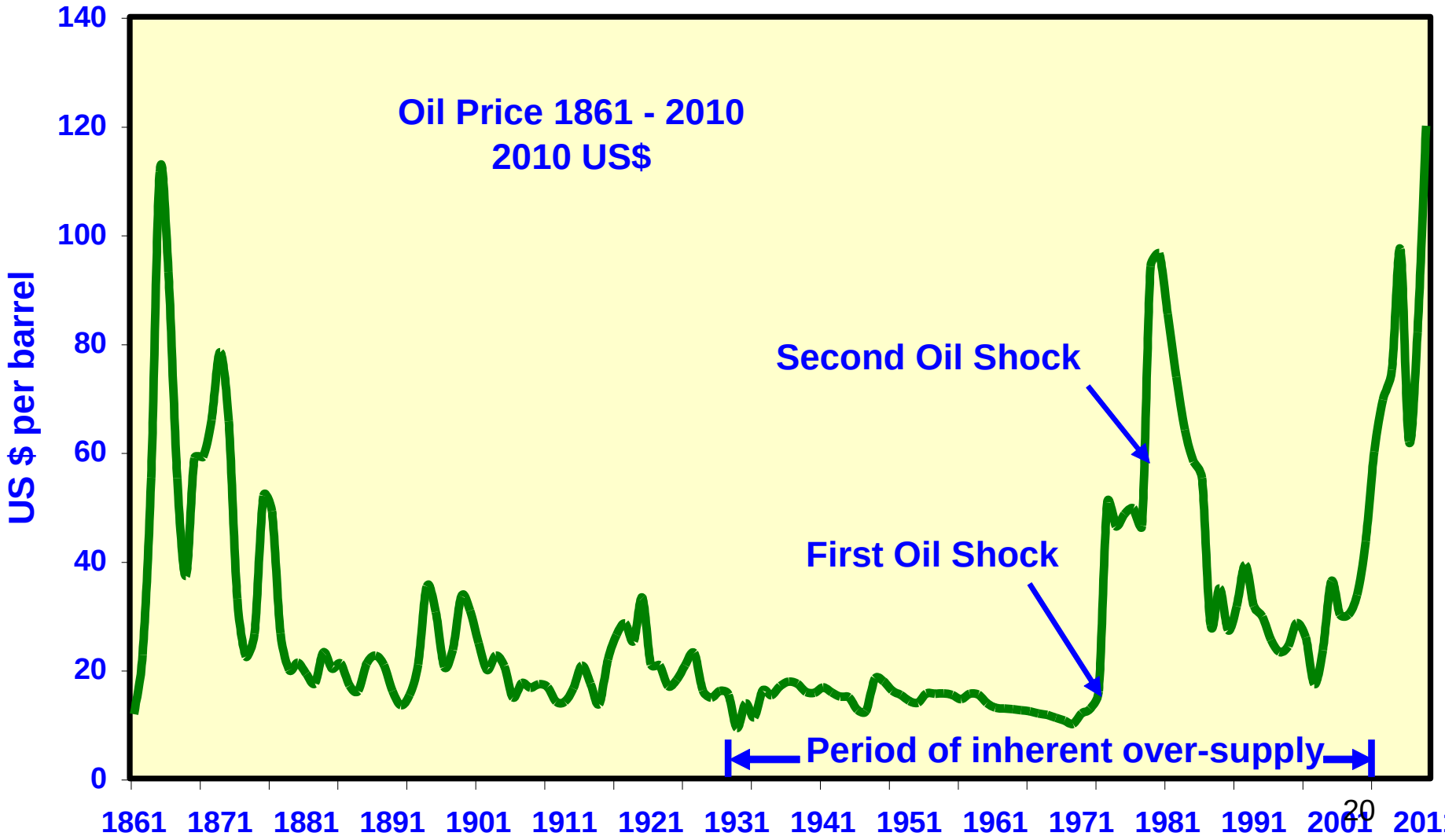
The average production cost of shale gas is $5.20 per gj.



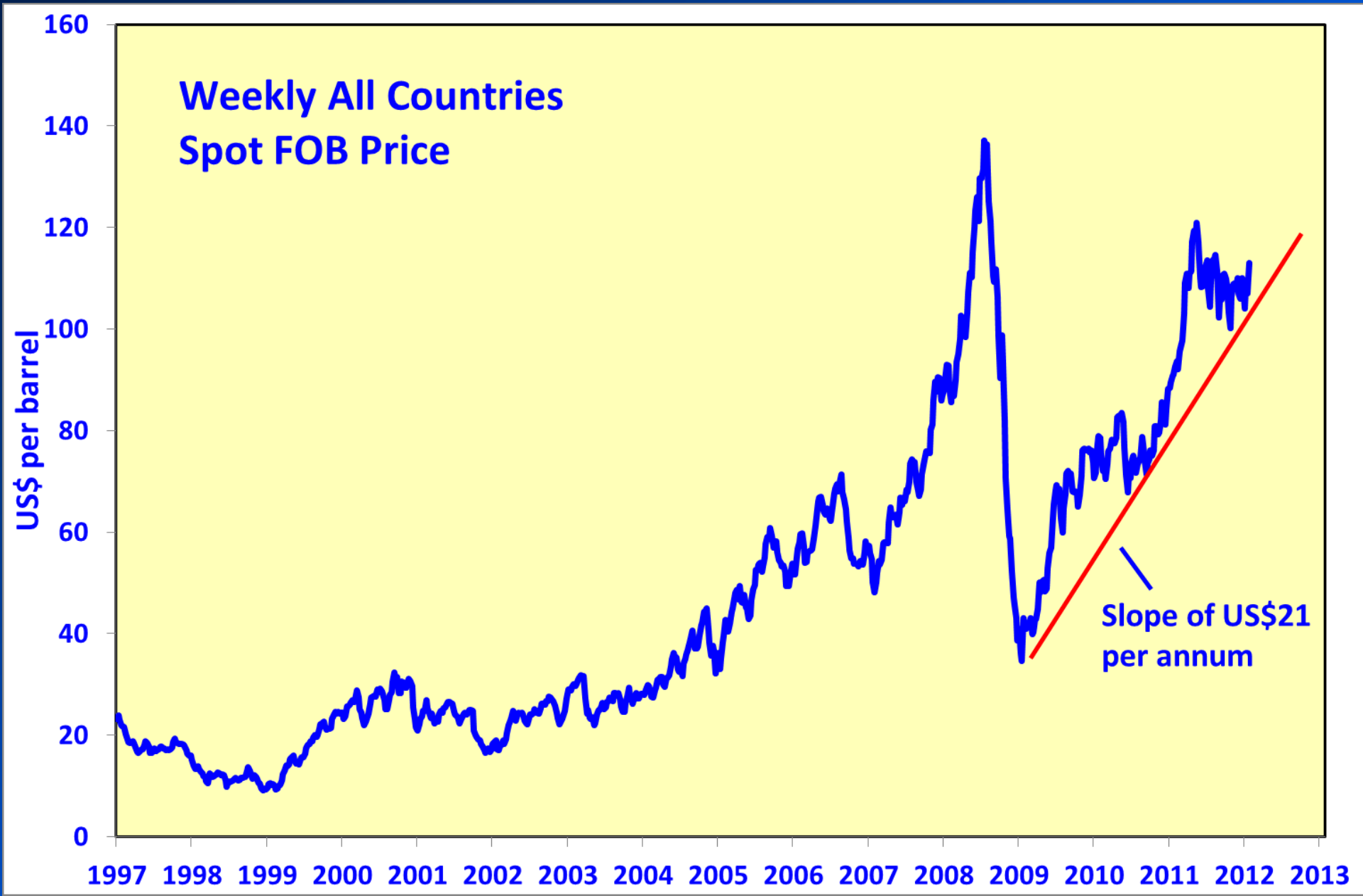
The shale gale will blow for about 20 years.



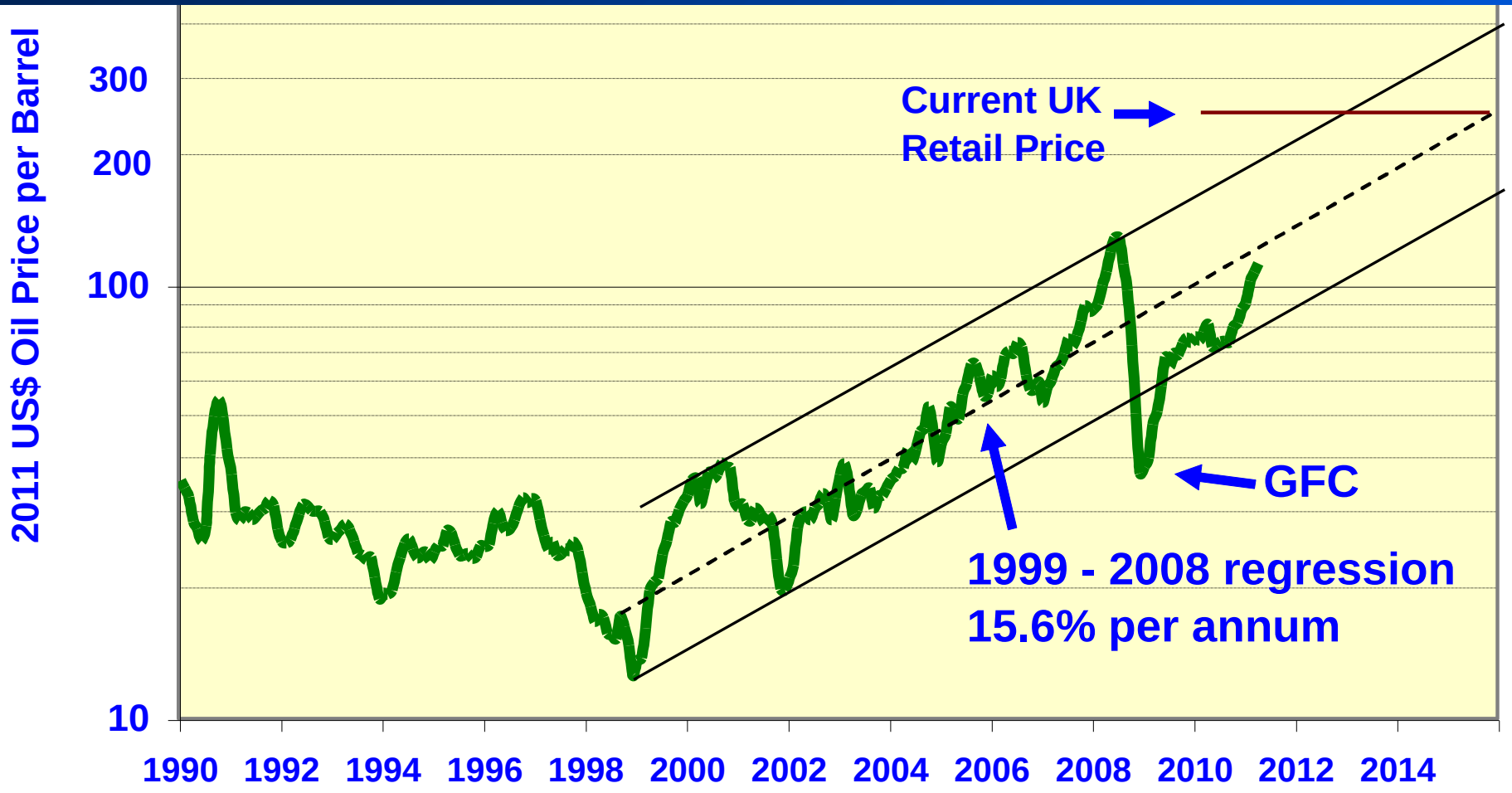
Historic Oil Price



The oil price is up despite the weak economy.

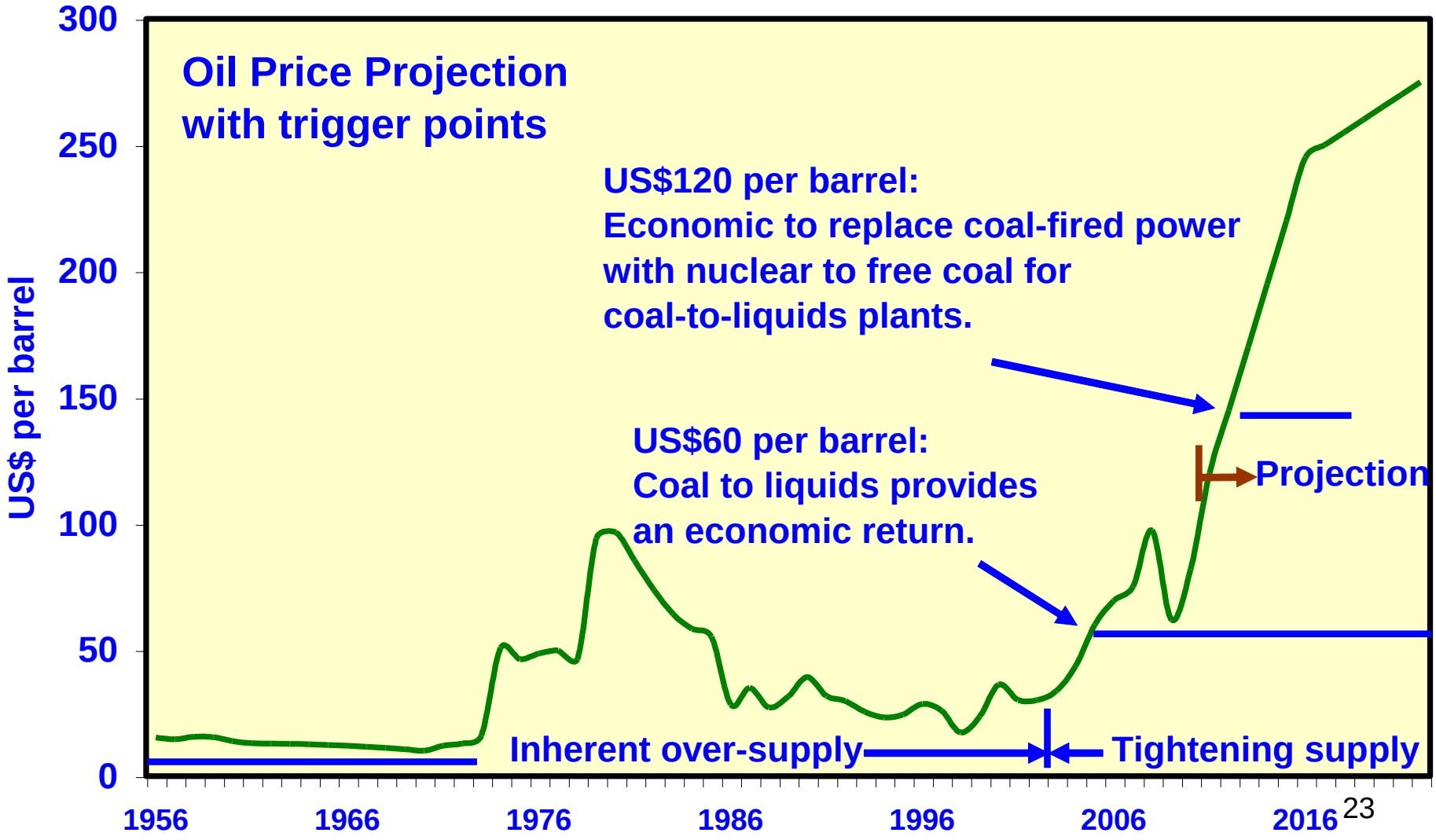


Oil Price Logarithmic Chart

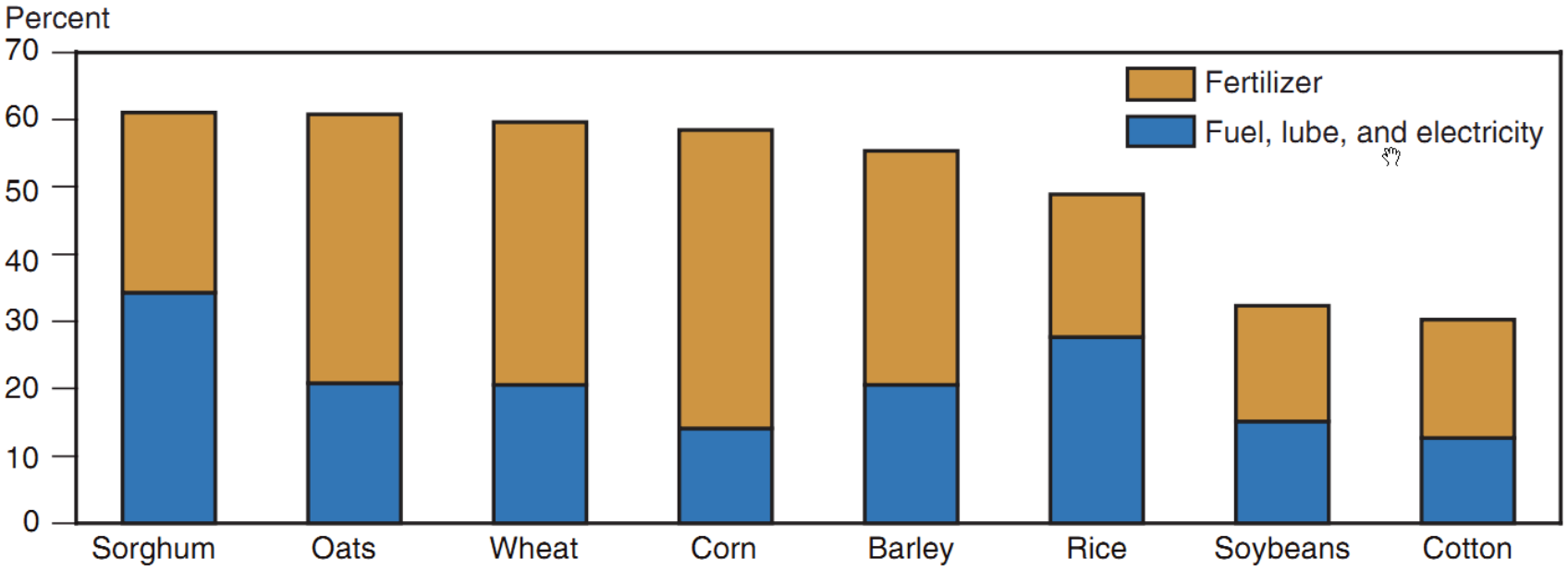


Will the established trend hold - $200/bbl by 2014?

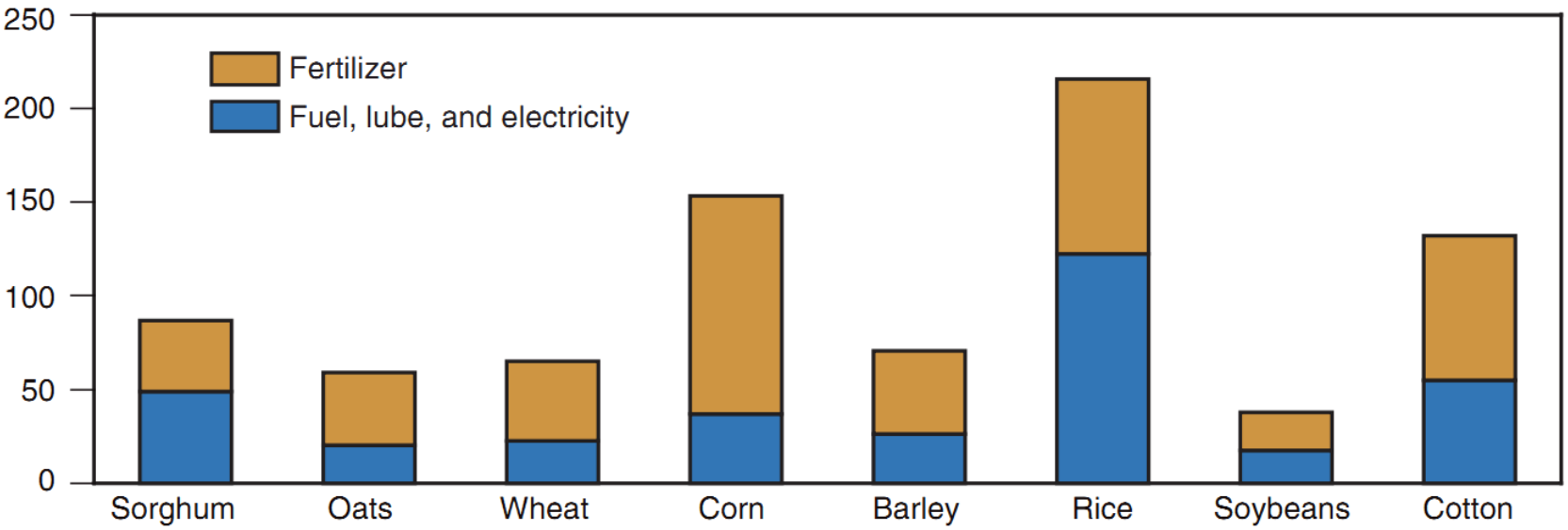
The oil price will drive nuclear plant building.



Energy-related inputs relative to total operating expenses, 2007-08 average



Energy-related expenses, selected crops, 2007-08 average

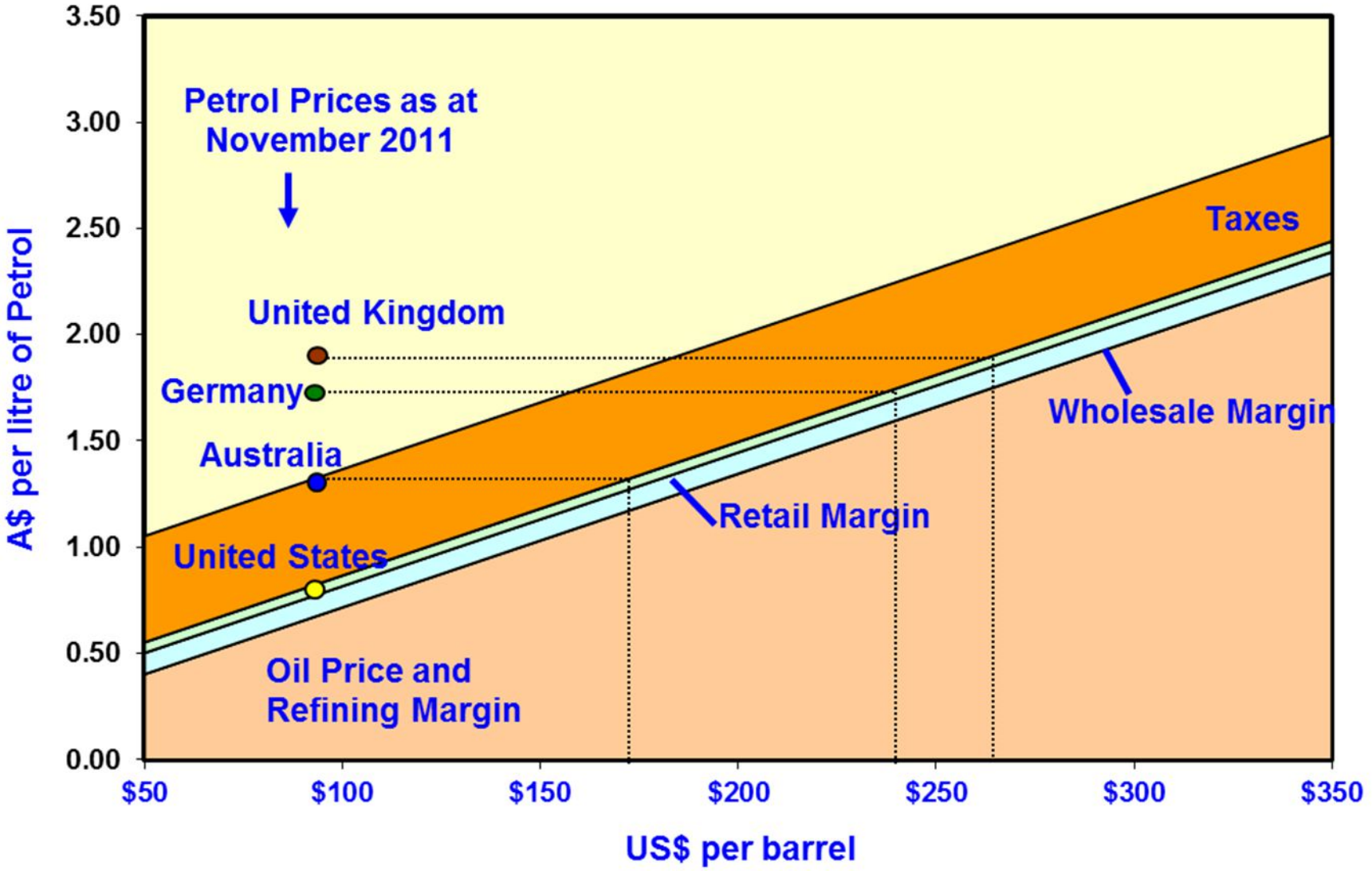


"Impacts of Higher Energy Prices on Agriculture and Rural Economies"
by Ronald Sands and Paul Westcott. ***USDA***

Based on the USDA figures and a US$200/bbl oil price:

Wheat and corn operating costs will be 60% higher in 2014.

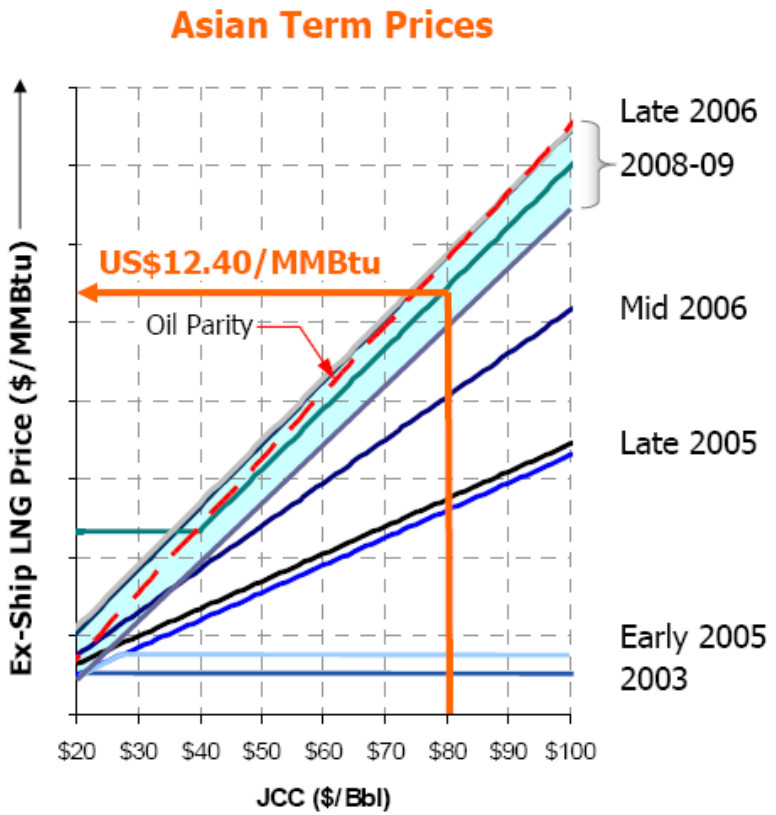
Variation with Oil Price



Australians are paying US$190/bbl for petrol, Germany US$340/bbl

The stupidity of displacing coal with natural gas to make electric power.

Continue to See Strong Long Term LNG Pricing



Source: Poten & Partners

- Recent contracts point to strong underlying demand
- Pricing reflects new supply-demand equilibrium
- Long-term Asia-Pacific pricing remains oil-linked

Might as well be burning oil.

Santos 4th March 2010

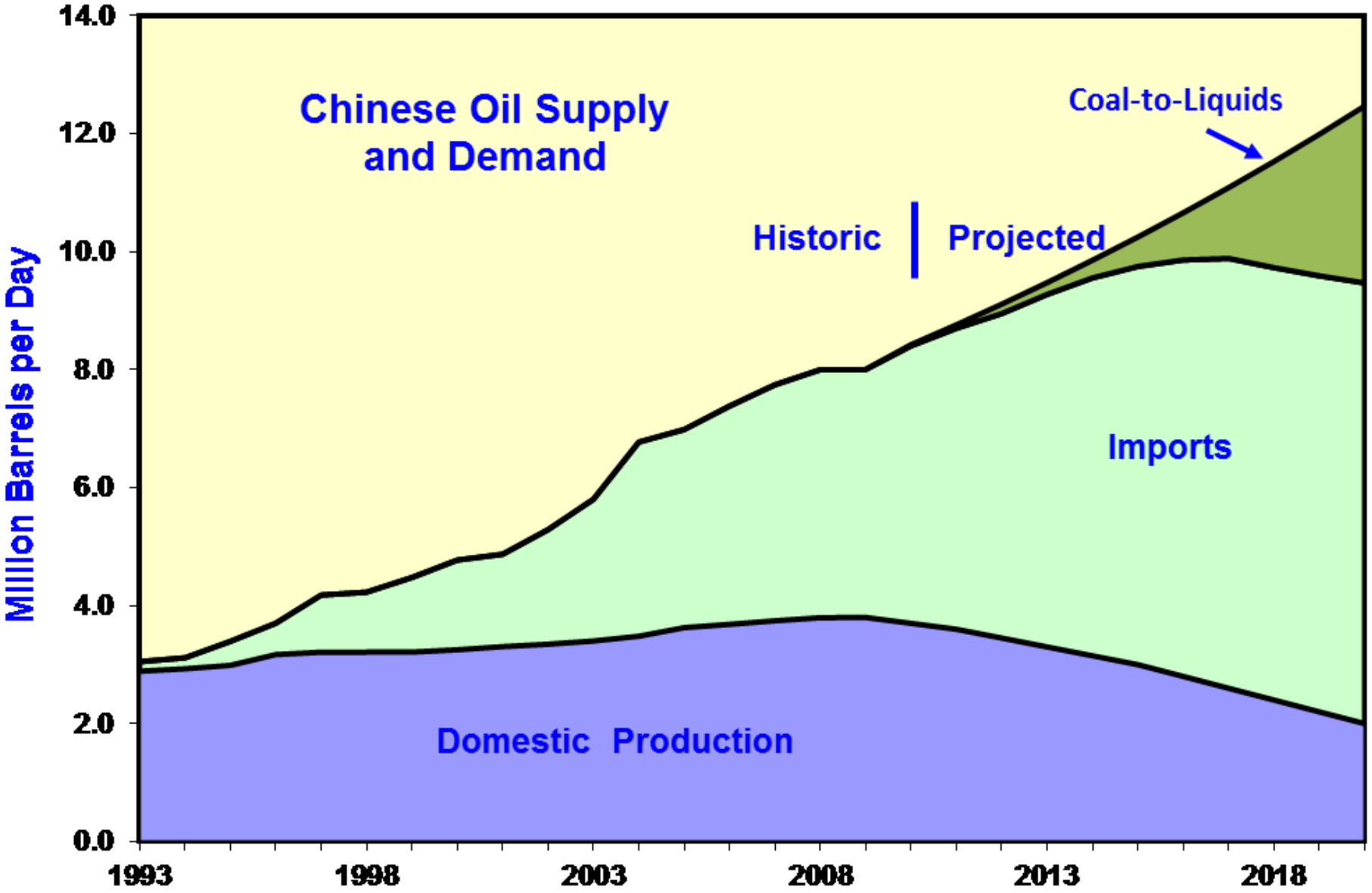
Santos
We have the energy.

The optimal solution

Rebuild the energy sector:

1. **Coal-to-Liquids (CTL) and compressed natural gas (CNG) replaces declining oil production.**
2. **Nuclear replaces coal for power generation as coal becomes too valuable as CTL feedstock.**
3. **Develop thorium reactors to replace uranium in nuclear energy.**

China is leaving oil before the rest of us.



Coal-to-Liquids in China is advancing rapidly.

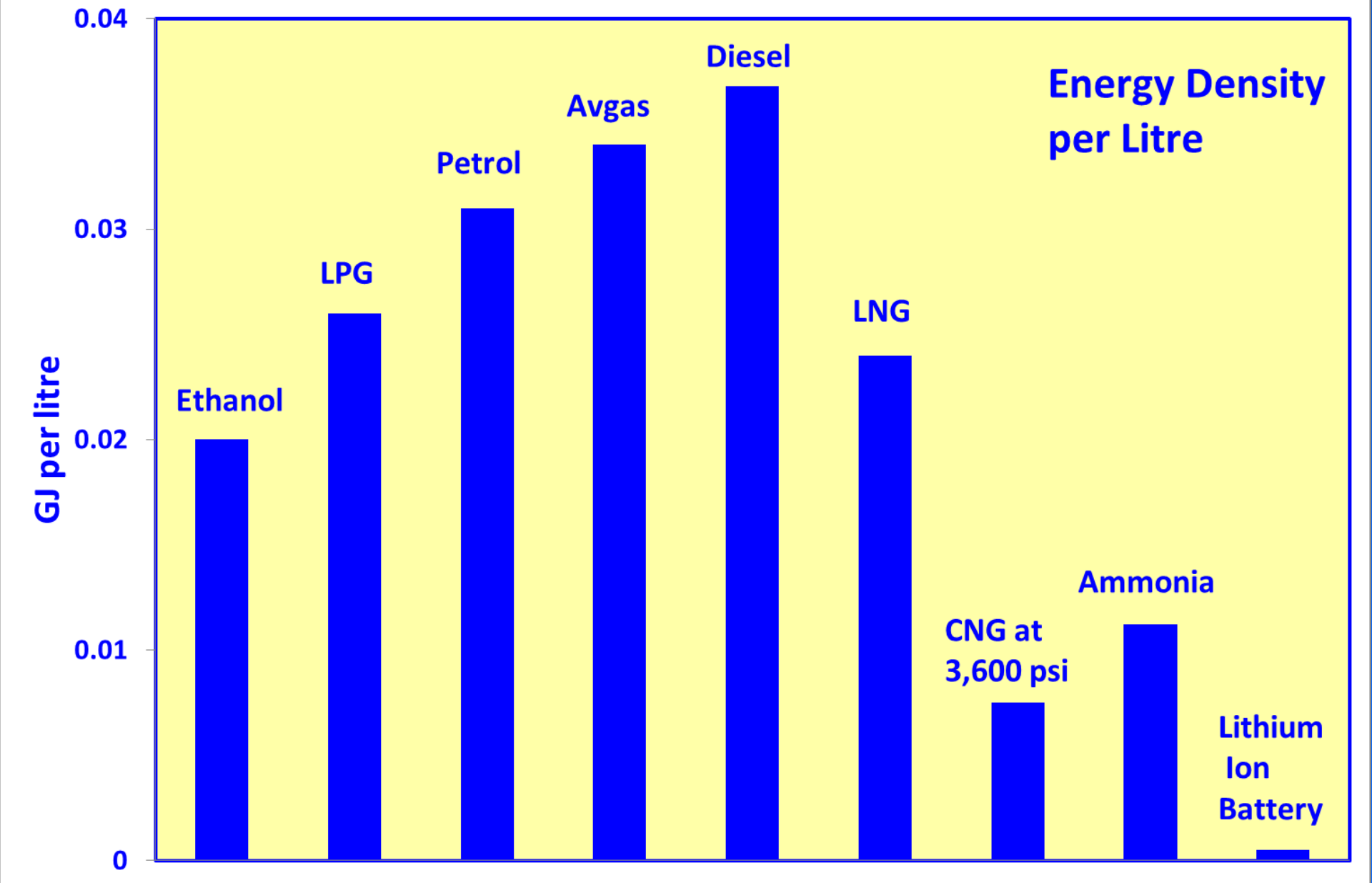
- Three Fischer-Tropsch and one liquefaction plant commissioned.
- A further three Fischer-Tropsch plants under construction.
- Total planned production in excess of 600,000 barrels per day.
- From ASIACHEM 2011: “Chinese CTL investors will pay active efforts in preliminary works for mega size CTL projects starting from 2011 and may realise commissioning of such projects before the year 2015”
- Who allowed the CTL gap with China?

Great Plains Synfuels Plant
North Dakota

Annual consumption is 6 million tonnes of lignite to produce 54 billion cubic feet of synthetic natural Gas – equivalent to 10,000 barrels/day.

It could be making diesel, and jet fuel.

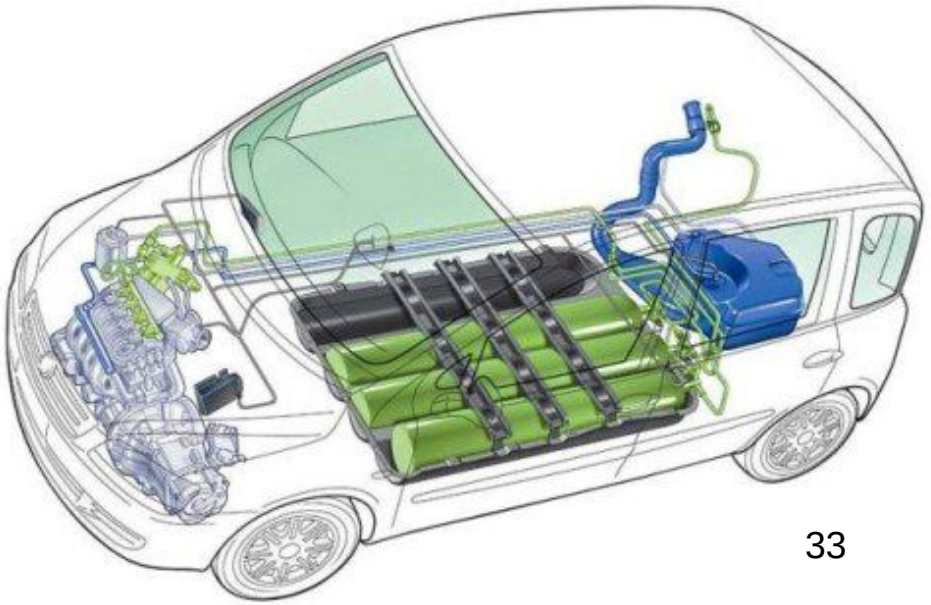
Energy Density of Transport Fuels



Natural gas vehicles – the electric car alternative

Fiat Panda with capacity for 12 kg of natural gas and has 30 litres of petrol backup

In a recent test in Europe, it did 720 km on €30 of natural gas - €0.04 per km



Relative efficiency of use of natural gas

	Natural Gas Vehicle		Electric Vehicle
1.0	unit of energy	1.00	unit of energy
0.5	four stroke engine	0.40	conversion to electric power
		0.36	delivered after transmission loss
		0.25	after charge/discharge loss
0.5	power to wheels	0.25	power to wheels

Therefore the electric car future should be nuclear-powered.

CTL will take our coal endowment 30% further than the power station / electric car route.

Coal-to-Liquids	Electric Vehicles
1.00 unit of energy	1.00 unit of energy
0.60 conversion to diesel	0.36 conversion to electric power
	0.32 delivered after transmission loss
	0.23 after charge/discharge loss
0.30 power to wheels	0.23 power to wheels

Diesel is storable, electric power isn't.

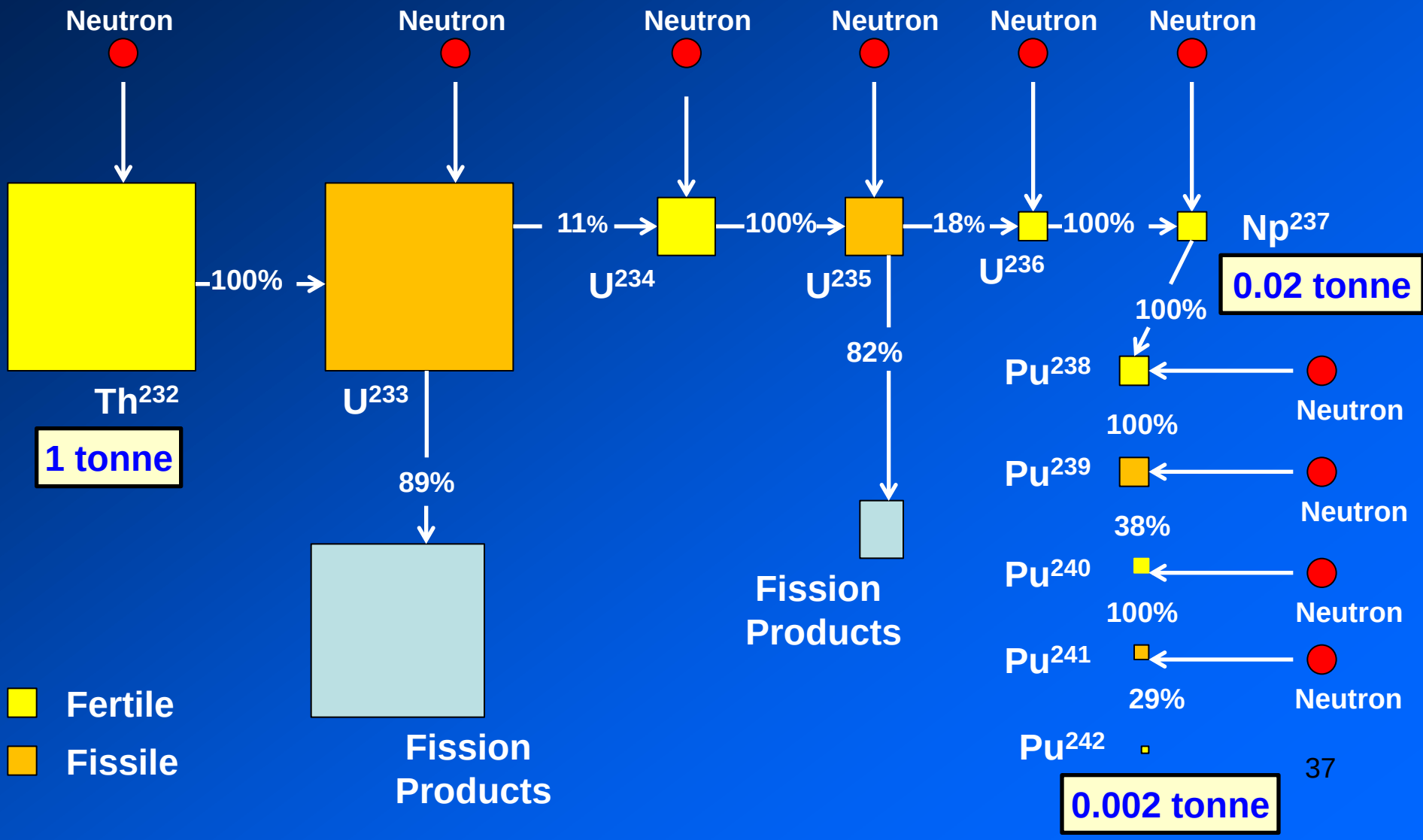
Thorium's Two Compelling Reasons:

1. A Thorium molten salt reactor is walk-away safe – Uranium can't be.

2. Thorium has one ten-thousandth the rate of high level waste production of the Uranium route.

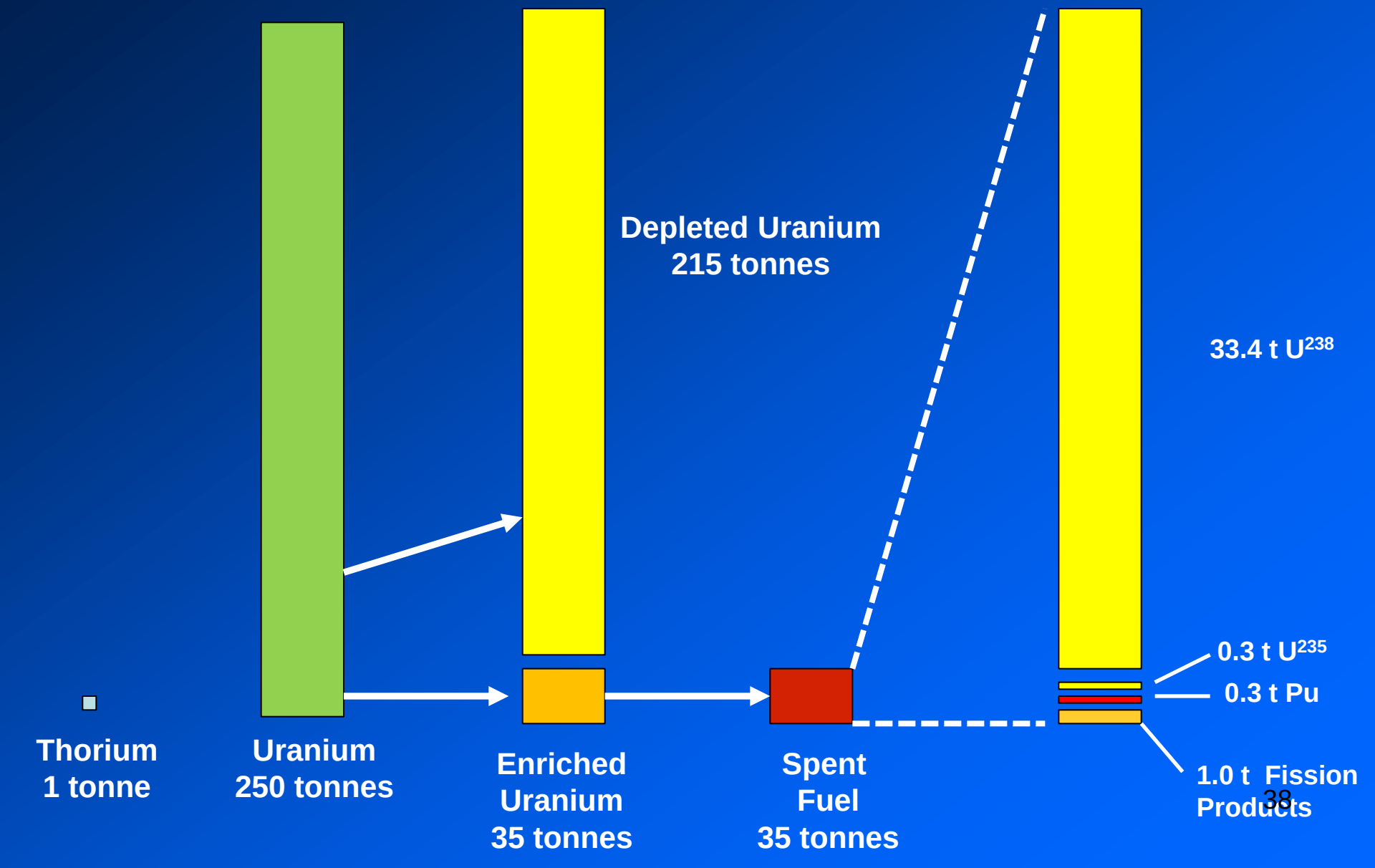
Thorium Process Route

1 GWe year

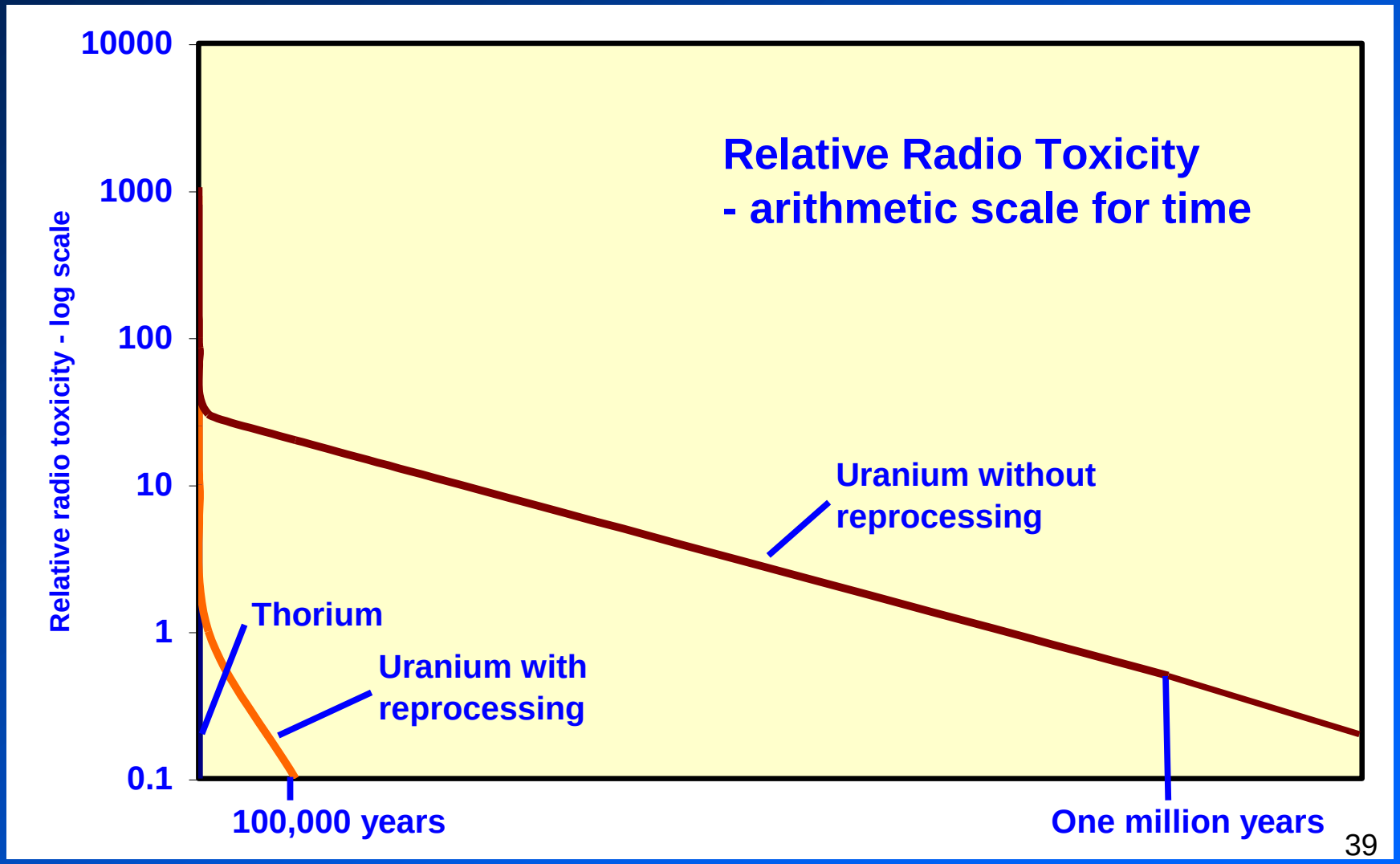


Uranium Light Water Reactor Route

1 GWe year



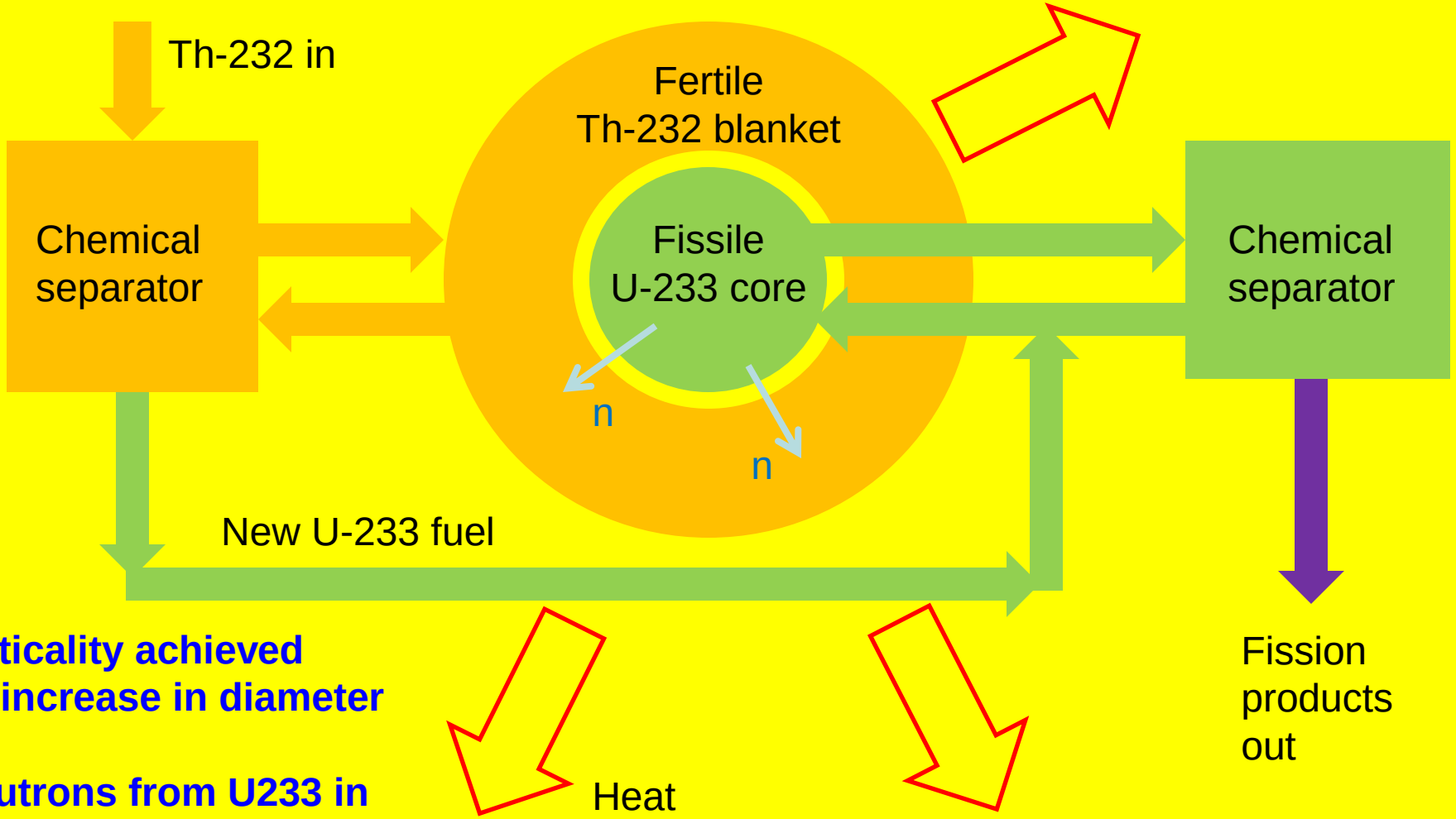
Relative Radio Toxicity
- time is arithmetic



Thorium

- Fertile but not fissile – needs a breeder reactor
- Four times as abundant as uranium.
- Half life of 14 billion years.
- By-product of mineral sands mining.
- The molten salt breeder reactor has the promise to provide low cost power with no long term, high level waste.
- The Chinese Government announced a molten salt thorium reactor project on 25th January 2011 – and specifically stated its intention to capture and control global IP on thorium reactors.

Two Fluid Thorium Reactor

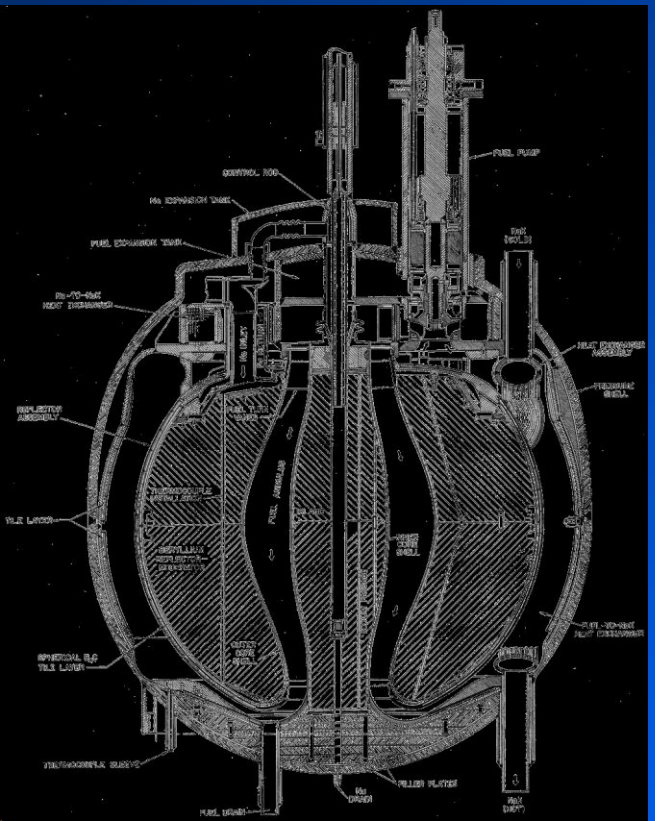


Criticality achieved by increase in diameter

Neutrons from U233 in the fuel salt irradiate thorium in the blanket salt

History: Aircraft Nuclear Program

Flew with an operating reactor 1955 – 1957 as a test bed. The reactor was not connected to the engines.



- The “Fireball”, or Aircraft Reactor Test, was the culmination of the ANP effort at ORNL.
- 235UF4 dissolved in NaF-ZrF4
- Designed to produce 60 MW of thermal power
- Core power density was 1.3 MW/litre
- NaK used to transport heat to jet engines at 1150 K
- The “Fireball” pressure shell was only 1.4 meters in diameter!

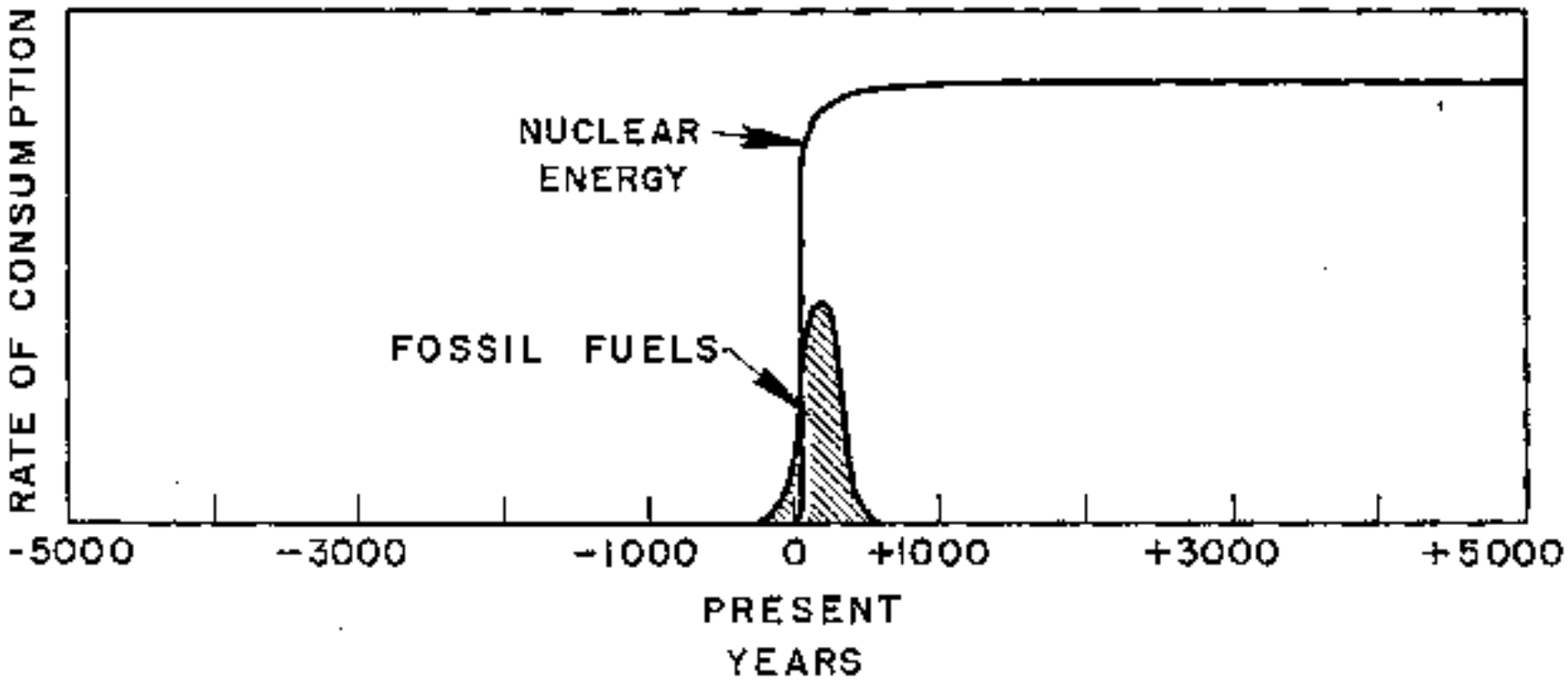
The future nuclear fleet might be floating

Akademik Lomonosov, 75 MWe

Concept

Hull launch
St Petersburg 30th June, 2010
Fuel loading into the two Reactors in 2012

We have to get nuclear power right if we are going to have a future.



gure 30 – Relative magnitudes of possible fossil-fuel and nuclear-
ergy consumption seen in time perspective of minus to plus 5000 years.

Hubbert 1965 “Nuclear Energy and the Fossil Fuels”

The Second Horseman

When the Lamb opened the second seal, I heard the second living creature say, "Come and see!" Then another horse came out, a fiery red one. Its rider was given power to take peace from the earth and to make men slay each other. To him was given a large sword.

Revelation 6:3-4

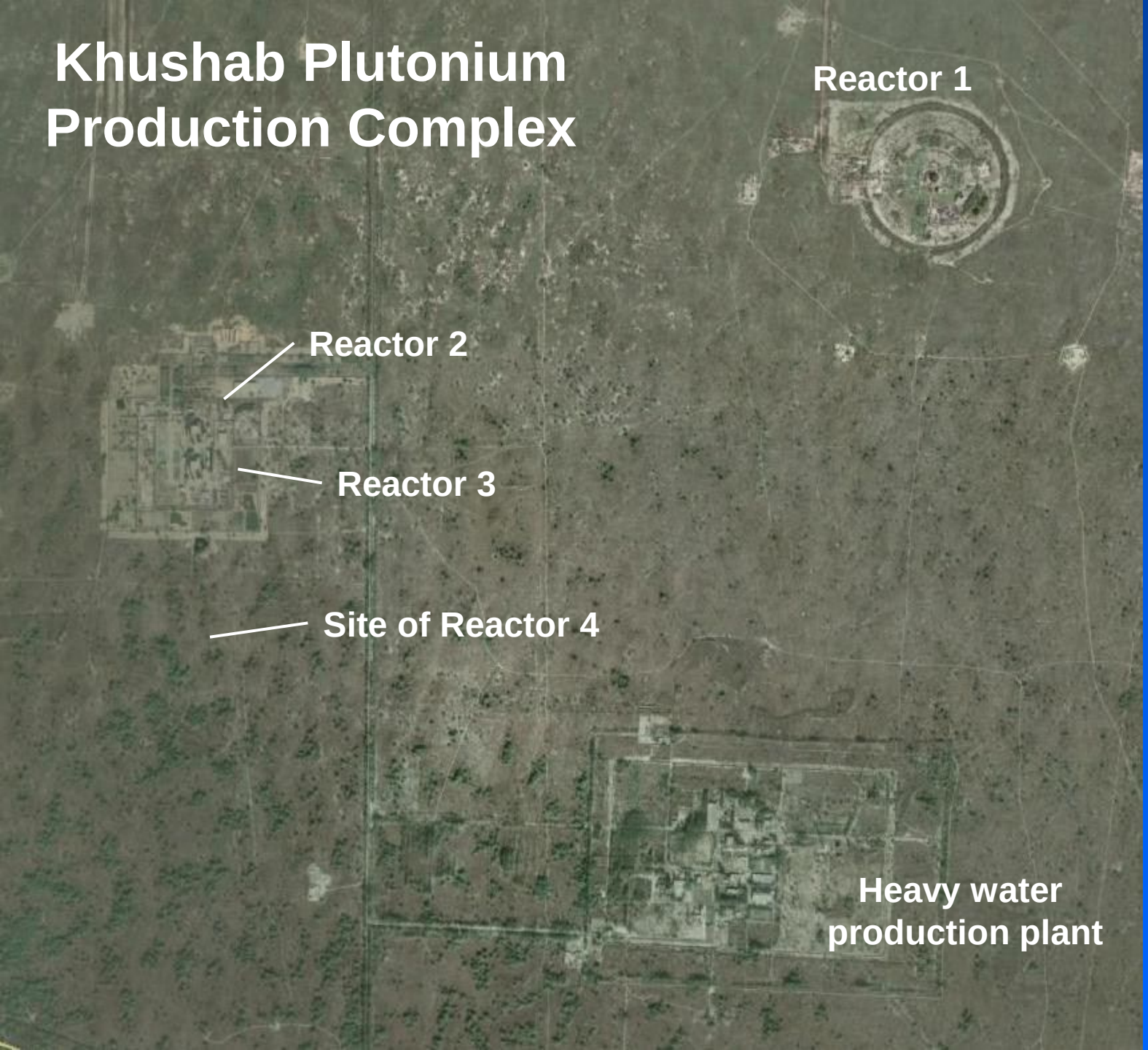
War

-The Pakistani nuclear weapon programme

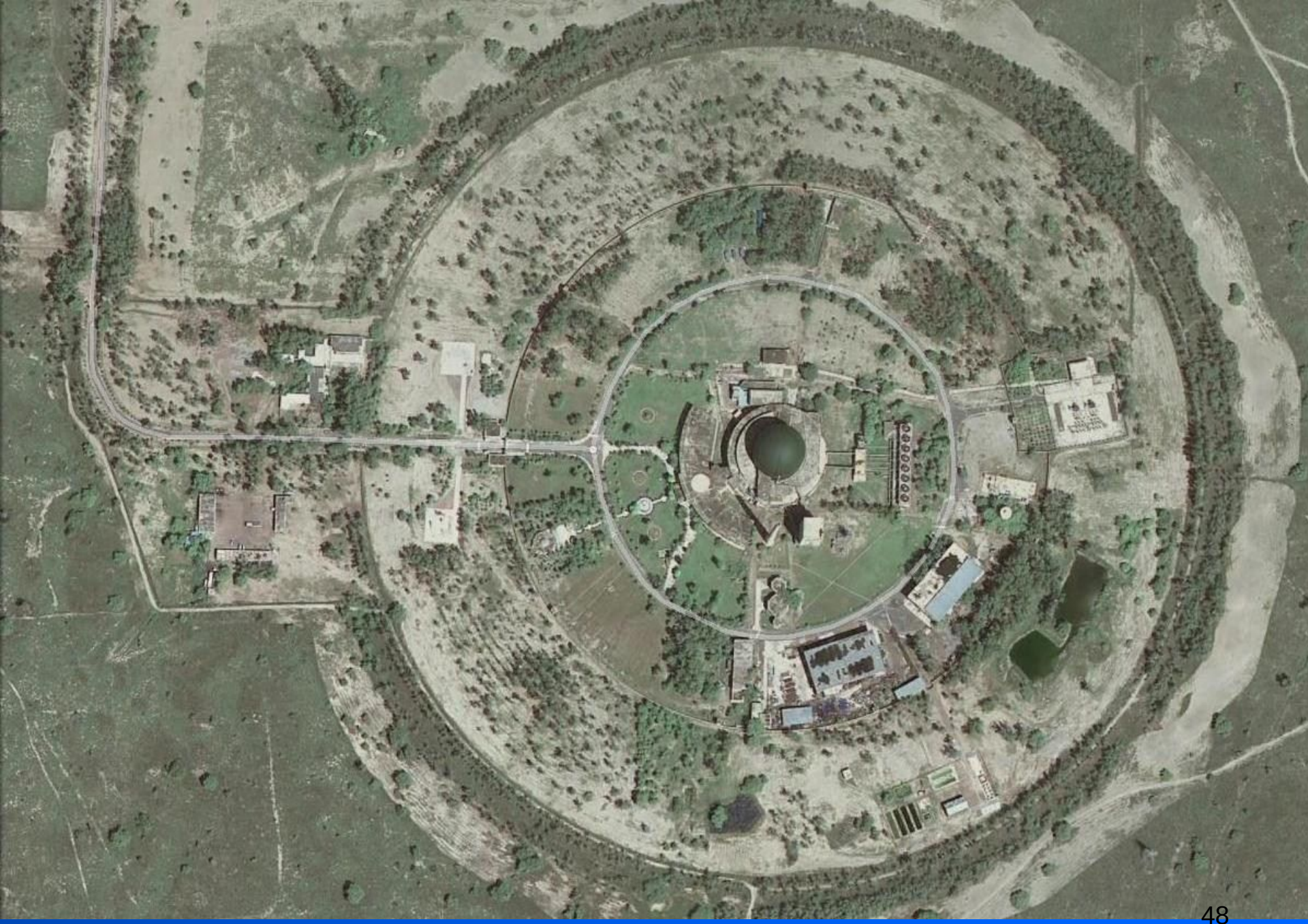
Pakistan Nuclear Timeline

1972	President Bhutto decides to build a bomb
1974	India explodes nuclear device
	Dr Kahn smuggles centifruge blueprints to Pakistan
1978	First enrichment of uranium
1983	90% enrichment achieved
1984	Bomb ready but test delayed due to Afghan war
1988	Missile delivery system developed, technology from China
	First plutonium reactor at the Khushab site
1998	First bomb tests - 6 devices in May
	programme was $20 million/year for 25 years
2001	Pakistan-sponsored attack on Indian Parliament
2002	Construction begins on second reactor at the Khusab site
2006	Construction begins on third reactor at the Khusab site
2008	Pakistan- sponsored attack on Mumbai
2011	Construction begins on fourth reactor at the Khusab site

Khushab Plutonium Production Complex



Location at:
32° 00’ N
72° 12’ E



First reactor at Khushab

Beyond deterrence, a war-fighting capability

Bombs	Missiles	Range
Current arsenal of approx. 100	Hatf 9	60 km
	Hatf 2	180 km
Upon completion of Khusab 4,	Hatf 3 (Ghaznavi)	300 km
build rate of 40 x 20kt bombs	Hatf 4 (Shaheen 1)	700 km
per annum	Shaheen 2	2000 km

Meanwhile, Pakistan has a literacy rate of 55% and frequent power blackouts due to fuel shortages.

Like Pakistan's population growth, there will be no end to Pakistan's bomb-build in the absence of an external event.

Possible Futures

1. Pakistan uses its nuclear weapons in a regional war.

2. Failed state outcome - weapons are sold to regional players with the funds.

Either way – the genie is out of the bottle and middle powers find that they can survive an exchange of low-yielding weapons.